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BY PHYSICS WALLAH

# UPSC WALLAH

# DISASTER MANAGEMENT

COMPREHENSIVE LEARNING SERIES FOR PRELIMS AND MAINS

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# Understanding Disaster Risk

# 1

## INTRODUCTION

Disasters, whether natural or man-made, have been part of man's evolution since time immemorial. **A disaster is an extreme disruption of the functioning of a society that causes widespread human, material, or environmental losses that exceed the ability of the affected society to cope with its own resources**. The Indian subcontinent is among the world's most disaster-prone areas. According to a report by the Geneva-based Internal Displacement Monitoring Centre, natural disasters, especially heavy floods and cyclones, triggered around 2.5 million internal displacements in India in 2022. Another report from the India Meteorological Department states that India recorded 2,227 human casualties due to extreme weather events in 2022.

## HAZARD

A hazard can be characterised as a difficult condition or event with the potential to cause harm to life, property, or the environment. It represents any source capable of inflicting damage, harm, or adverse health effects on individuals or their surroundings.

- **Natural Hazards:** Natural hazards arise from naturally occurring physical phenomena. These can manifest as geophysical events (earthquakes, landslides, tsunamis, and volcanic activity), hydrological events (avalanches and floods), climatological events (extreme temperatures, drought, and wildfires), meteorological events (cyclones and storms surge), or biological events (disease, epidemics and insect/animal plagues).
- **Anthropogenic Hazards:** In contrast, anthropogenic hazards stem from human actions or inactions, distinctly different from natural hazards. These hazards can adversely impact humans, other organisms, biomes, and ecosystems. Examples of anthropogenic hazards encompass pollution, deforestation, the use of herbicides and pesticides, and chemical spillages.

### Difference between Hazard and Disaster

If a hazard like a cyclone hits an unpopulated area, say an unpopulated coast, it need not be considered as a disaster. However, it will be considered a disaster if life and property are seriously damaged. A hazard may be regarded as a pre-disaster situation, in which some risk of disaster exists, because the human population has placed itself in a situation of risk. Thus mitigation becomes significant to avoid converting Hazard into disaster.

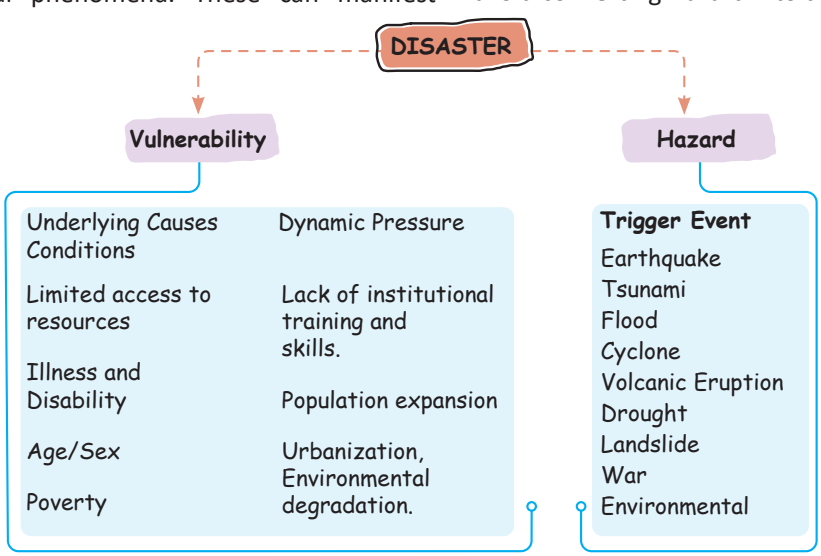


**Fig 1.1:** Hazard and Vulnerability turning into Disaster

### How Human Activities are Converting Hazards into Disasters?

**The human-induced factors can greatly aggravate the adverse impacts of a natural disaster.** The UN Intergovernmental Panel on Climate Change (IPCC) has shown that human-induced climate change has significantly increased both the frequency and intensity of extreme weather events. **While heavy rains, cyclones, or earthquakes are all natural, the impacts may, and are usually, worsened by many factors related to human activity.** Extensive industrialization and

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urbanisation increase both the probability of human-induced disasters and the extent of potential damage to life and property from both natural and human-induced disasters.

### Case Study- Shimla Landslide 2023: From Hazard to Disaster

The tragic Shimla landslide of 2023 exemplifies how a **natural hazard transformed into a devastating disaster** due to a series of avoidable missteps. While heavy rainfall was the trigger, years of environmental disregard and reckless development set the stage for catastrophe. Unchecked deforestation stripped the slopes of their protective cover, making them vulnerable to erosion and waterlogging. Unplanned urban sprawl encroached on fragile hillsides, adding unnecessary weight and altering drainage patterns. Poorly built roads carved scars into mountains, further destabilising the terrain. In essence, human actions turned a natural event into a preventable tragedy.

## VULNERABILITY

According to the United Nations Office for Disaster Risk Reduction (UNDRR) **Vulnerability** is defined as **conditions influenced by physical, social, economic, and environmental factors or processes that make a community more likely to be affected by hazards.** Vulnerability relates to several factors, including:

- **Physical factors:** Poor design and construction of buildings, unregulated land use planning, etc.
- **Social factors:** Inequality, marginalisation, social exclusion and discrimination by gender, social status, disability and age. For example, **Sagar Island,** the largest inhabited estuarine island of Sundarbans, is experiencing severe coastal erosion, frequent cyclones, flooding, storm surges, and breaching of embankments, resulting in land, livelihood, and property loss, and the displacement of people at a huge scale. This is further intensified by increased threats due to climate change as a result of their higher exposure and lesser adaptive capacity.
- **Economic factors:** Poverty, the uninsured informal sector, vulnerable rural livelihoods, dependence on single industries, globalisation of business and supply chains, etc.
- **Environmental factors:** These include poor environmental management, overconsumption of natural resources, decline of risk regulating ecosystem services, climate change, etc. Recent examples of severe air pollution could have heightened Covid-19 risk in South Asia.

### Case Study: Structural Risks during a Hazard: Earthquakes and Low-Strength Masonry in Nepal

**Structural Risk:** Low-strength masonry of stone or bricks with mud mortar is the dominant building typology in Nepal and has been used as a building material since ancient times. It is still used in many parts of the country. Construction of early monuments, temples and residential buildings was generally limited to materials that were readily available and easily worked by local artisans. The trend at present is to use cement-based construction, especially in urbanising areas.

**Disaster:** In April 2015, an earthquake and its aftershocks killed more than 8,800 people and injured more than 22,000 largely due to the **damage to low strength masonry structures.** Among other factors, the impact on life depended on building vulnerability and the evolution of construction methods. Indeed, fatalities from the earthquake indicated that, on average, there had been a reduction in building vulnerability in urban areas, whereas buildings in rural areas remained highly vulnerable.

| | Low-strength | Cement masonry | Reinforced concrete | Total |
|---|---|---|---|---|
| Partially damaged | 173 867 | 65 859 | 16 971 | 256 697 |
| Fully damaged | 474 025 | 18 214 | 6 613 | 498 852 |

**Mitigation:** The National Society for Earthquake Technology in Nepal started conducting training on earthquake resistant construction of vernacular buildings for masons in the late 1990s, and the government has taken the lead with national and international support, especially after the 2015 earthquake. There remains a continuing need for the institutionalisation of a comprehensive, multi-tier and hands-on training certification programme to teach further skills in improving the seismic performance of buildings and delete developing nationwide capacities in earthquake resistant reconstruction.

## EXPOSURE

**Definition:** Exposure is the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas. **If a hazard occurs in an area of no exposure, then there is no risk**.

**Lekima vs Yolanda:** This can be exemplified by typhoons (tropical cyclones that occur in the Pacific Ocean). In October 2013 a Category 5 super typhoon (known as Lekima) hit the North West Pacific Ocean. Its winds reached peaks of around 240 kilometres per hour, but caused no impact on people or assets. In November 2013 another Category 5 Super Typhoon



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Haiyan (Yolanda) hit the region, with winds peaking at 315 kilometres per hour. Haiyan affected 11 million people, causing more than 6000 casualties and the loss of more than 1.5 billion US dollars. The difference in impact was because there were no people or property in the path of Lekima; in other words, there was no exposure.

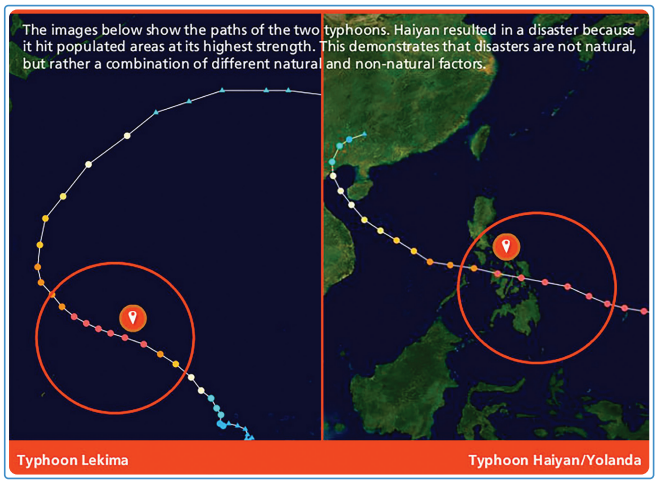


**Fig 1.2:** Path of Typhoon Haiyan and Typhoon Lekima

## What Drives Exposure?

People and economic assets become concentrated in areas exposed to **hazards through processes such as population growth, migration, urbanisation and economic development.** Many hazard-prone areas, such as coastlines, volcanic slopes and floodplains, attract economic and urban development, offer significant **economic benefits or are of cultural or religious significance to the people who live there**. As more people and assets are exposed, risk in these areas becomes more concentrated. At the same time, risk also spreads as cities expand and as economic and urban development transform previously sparsely populated areas.

## RISK

Risk is the probability of an outcome hurting people, systems or assets. Risk looks at the chance of harmful outcomes or expected losses, like deaths, injuries, property damage, disruptions to livelihoods, economic activity, and environmental harm. This depends on the interplay between natural or human-made hazards and vulnerabilities. It's calculated as:

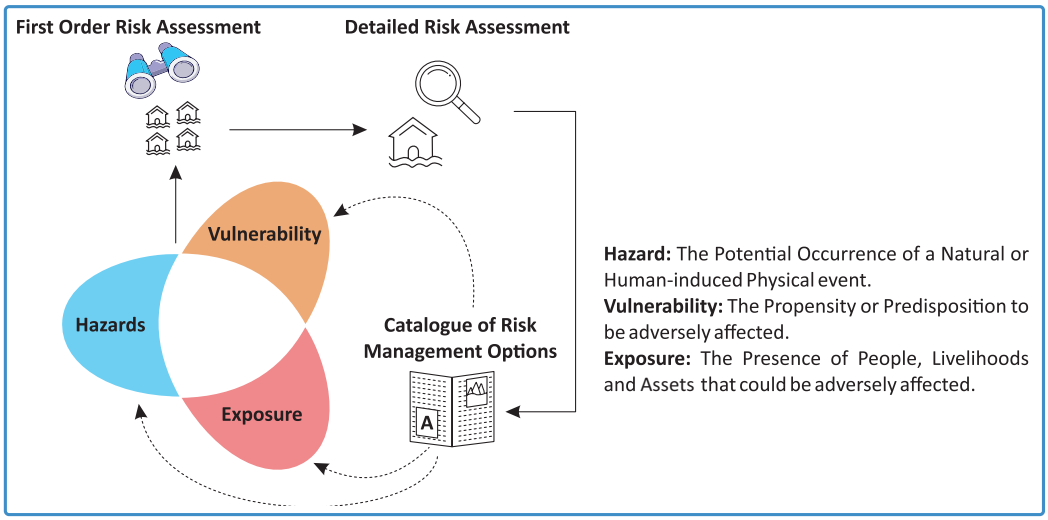


**Fig. 1.3:** Risk Assessment

| Different Approaches of Managing Risk | | |
|---|---|---|
| **Approach** | **Description** | **Examples** |
| **Risk Acceptance** | Making informed decisions to accept the potential consequences and likelihood of a specific risk. | Two coastal villages in Odisha, **Venkatraipur in Ganjam district and Noliasahi** in Jagatsingpur district earned the recognition of being **'Tsunami Ready' from the UNESCO-Intergovernmental Oceanographic Commission,** making India the first country in the Indian Ocean Region to establish such high levels of disaster preparedness at the community level. |



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| | | |
|---|---|---|
| **Risk Avoidance** | Choosing not to engage in activities that might lead to a risk occurrence. | Communities situated in areas susceptible to wildfires or mudslides may opt to relocate to safer zones entirely. While a drastic measure, it proves effective in avoiding potential disasters. |
| **Risk Reduction** | Utilising appropriate methods to decrease the likelihood of a risk and mitigate its consequences. | By enforcing stringent building codes and retrofitting existing structures in earthquake-prone zones, the damage and casualties during earthquakes can be significantly reduced. |
| **Risk Transfer** | Shifting the risk burden to someone else is often achieved through mechanisms like insurance. | Homeowners in flood-prone regions can secure flood insurance to shift the financial risk of flooding to the insurance company. This provides financial support for repairs and reconstruction after a flood. |

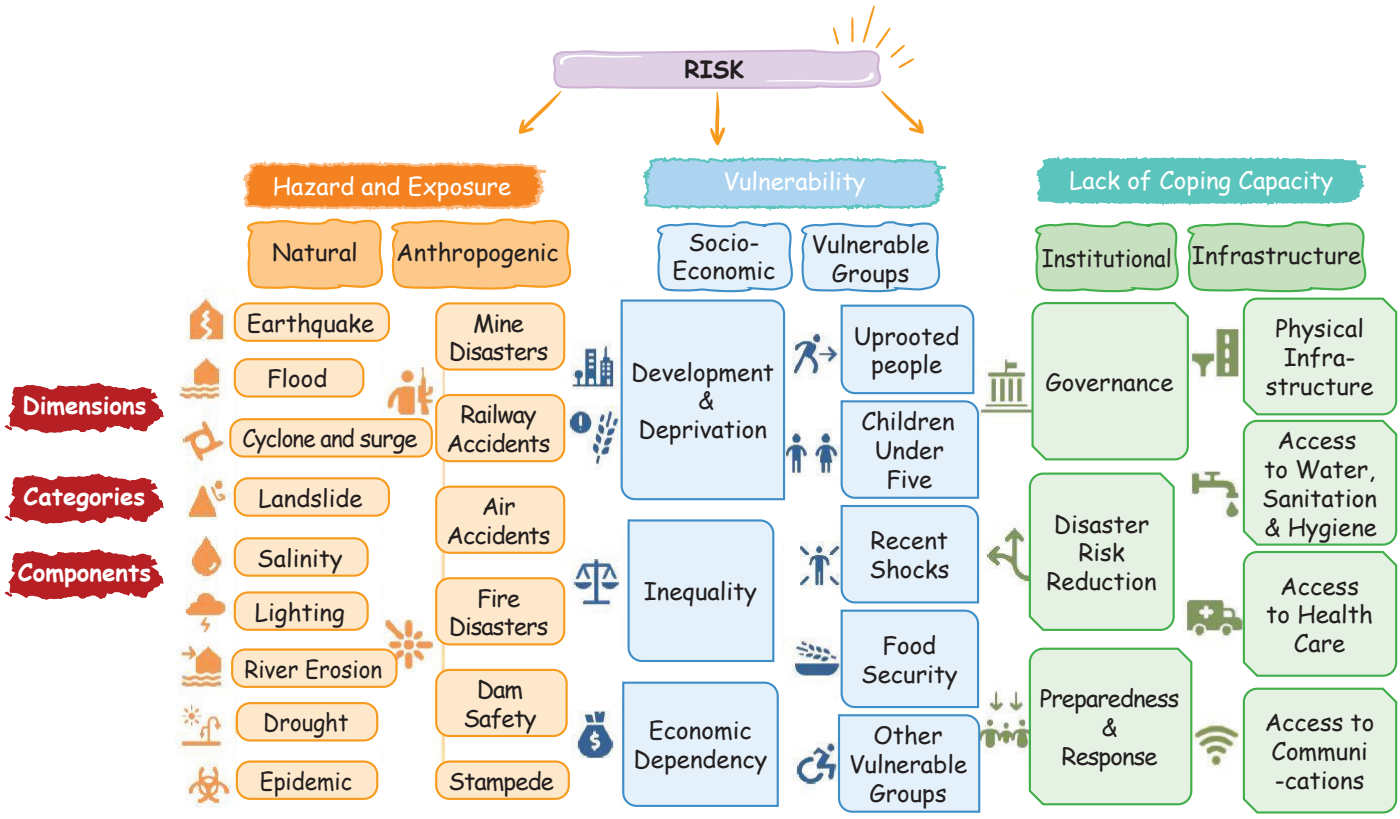


**Fig. 1.4:** Factors igniting Risk Probability

**IGNITE YOUR MIND**

Imagine forecasting based on animal behaviour, plant indicators, and ancient storytelling alongside data analysis.

## Importance of Vulnerability Analysis and Risk Assessment

Vulnerability analysis and risk assessment are pivotal for pre-disaster management in the following ways:

- **Informed Decision-Making:** They empower decision-makers with insights into potential threats, guiding resource allocation and optimising interventions.
  - For example, in contemporary times, cyclones are accurately forecasted in advance, enabling us to proactively implement suitable measures to mitigate potential disasters.
- **Effective Mitigation Strategies:** These assessments enable tailored mitigation strategies (like community education, early warning systems, infrastructure resilience, etc.), fostering community engagement and preparedness.
- **Early Warning Systems:** By identifying hazards and vulnerabilities, early warning systems are enhanced, facilitating proactive measures and reducing disaster impacts.



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- **Policy Development and Planning:** The data informs evidence-based policy development and planning, aligning strategies with specific risks. The aim is to minimise losses and casualties through timely interventions.
  - The NDMA has formulated guidelines addressing a spectrum of disasters for effective mitigation.
- **Community Engagement:** Engaged communities actively participate in risk reduction, contributing to overall resilience. Continuous monitoring and adaptation ensure strategies remain effective and responsive. **Example:** Amid the Kerala floods, successful community engagement played a pivotal role in effectively managing the extensive disaster.
- **Reduced Losses and Casualties:** By identifying vulnerabilities and assessing risks, disaster management aims to reduce the potential impact on lives, property, and the environment.
  - **Example:** Vulnerability analysis allows timely evacuations before cyclone Bipajoy, saving lives and protecting property.

## DISASTERS

As per the 2005 Disaster Management Act "disaster" means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area.

### Etymology

The term 'Disaster' has its origins in Middle French, désastre, and Old Italian, Disastro, both of which trace back to the Greek pejorative prefix δυσ- (dus-), meaning "bad," and αστήρ (aster), meaning "star." The fundamental meaning of the word disaster, which translates to "bad star" in Greek and Latin, stems from an astrological concept. In ancient times, this term was employed to describe the ruin or downfall of a star, reflecting a catastrophic event.

### Classification of Disasters

As per the Sendai Framework for Disaster Risk Reduction 2015-2030, disasters can be classified in the following manners:

1. **Small-scale disaster:** A type of disaster only affecting local communities which require assistance beyond the affected community. E.g. Landslides
2. **Large-scale disaster:** A type of disaster affecting a society which requires national or international assistance. **For example** 2011 Tohoku earthquake and tsunami.
3. **Frequent and infrequent disasters:** Depend on the probability of occurrence and the return period of a given hazard and its impacts. The impact of frequent disasters could be cumulative, or become chronic for a community or a society.
4. **Slow-onset disaster:** It is defined as one that emerges gradually over time. Slow-onset disasters could be associated with, e.g., drought, **desertification, sea-level rise, and epidemic disease.**
5. **Sudden-onset disaster:** This one is triggered by a hazardous event that emerges quickly or unexpectedly. Sudden-onset disasters could be associated with, e.g., earthquakes, volcanic eruptions, flash floods, chemical explosions, critical infrastructure failures, and transport accidents.

## GLOBAL DIMENSIONS OF DISASTERS

- **Increasing Trend in Disaster Losses:** In recent times, the world has witnessed a concerning escalation in disaster losses, attributed to the forces of urbanisation and a growing global population as shown in the above figure.
- **Major Recorded Disasters (2000-2019):** As per the UNDRR report during the period 2000 to 2019, there were 7,348 major recorded disaster events, resulting in 1.23 million fatalities, affecting 4.2 billion people, and causing approximately US$2.97 trillion in global economic losses. This signifies a substantial increase compared to the preceding two decades.
- **Rise in Climate-Related Disasters:** The UNDRR report attributes much of the increase to climate-related disasters, notably extreme weather events. The number of climate-related events surged from 3,656 (1980-1999) to 6,681 (2000-2019).
- **Floods and Storms:** Over the last two decades, major floods more than doubled from 1,389 to 3,254, and storm incidences increased from 1,457 to 2,034. Floods and storms emerged as the most prevalent events.
- **Heatwaves and Drought:** Heatwaves contribute to 148,000 of the 164,000 lives lost due to extreme temperatures, with 92% of these deaths happening in high-income countries, particularly Europe. Africa experiences the highest incidence of drought, with the report advocating for improved data collection on indirect deaths from drought.

### 2023 Turkey–Syria Earthquakes

The 2023 Turkey-Syria earthquakes were a devastating series of tremors that struck southern and central Turkey and northern and western Syria on February 6, 2023. The initial earthquake, with a magnitude of 7.8, was followed by a second powerful earthquake of magnitude 7.5, causing widespread destruction and loss of life.



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- **Epicentre:** The epicentre of the first earthquake was near Gaziantep, Turkey, close to the border with Syria.
- **Intensity:** The earthquakes had a maximum Mercalli intensity of XII (Extreme) in the epicentral region.
- **Aftershocks:** Over 570 aftershocks were recorded within the first 24 hours of the main earthquake, and over 30,000 by May 2023.
- **Fatalities:** Over 57,000 people were killed in the earthquakes, with tens of thousands more injured.

**IGNITE YOUR MIND**

Can international cooperation and financial aid create a more equitable system for disaster preparedness and response, ensuring no community is left behind in the face of climate-driven catastrophes?

- **Concerted International Action:** Disasters affect all countries, but developing countries are more vulnerable and bear a disproportionate burden of the impacts. Concerted action by the international community is needed to address regional vulnerabilities.
- **Disproportionate Impact on Developing Countries:** Since 1991, two-thirds of disaster victims have been from developing countries, contrasting with a mere 2% from developed nations. This stark difference underscores the heightened vulnerability of developing nations to large-scale disaster events.
- **Rising Challenge:** According to the UNDRR, by 2030, with current climate projections, the world will face some 560 disasters per year.

## Linking Disasters around the World

- **A Study from the UN University:** A UN study looked at 10 different disasters that occurred in 2020 and 2021, and finds that, even though they occurred in very different locations and do not initially appear to have much in common, they are, in fact, interconnected. Over the 2020-2021 period covered by the research organisation, **several record-breaking disasters took place, including the COVID-19 pandemic, a cold wave which crippled the US state of Texas, wildfires which destroyed almost 5 million acres of Amazon rainforest, and** 9 heavy storms in Vietnam - in the span of only 7 weeks.
- **Arctic-Texas link:** An example of this is the recent heatwave in the Arctic and the cold wave in Texas, USA. In 2020, the **Arctic experienced unusually high air temperatures and the second-lowest amount of sea ice cover on record.** This warm air destabilised the polar vortex, a spinning mass of cold air above the North Pole, allowing colder air to move southward into North America, contributing to the sub-zero temperatures in Texas, during which the power grid froze up, and 210 people died.
- **COVID and the Cyclone:** Another example of the connections between disasters is Cyclone Amphan, which struck the border region of India and Bangladesh. In an area where almost 50 per cent of the population is living under the poverty line, the COVID-19 pandemic and subsequent lockdowns left many people without any way to make a living, including migrant workers who were forced to return to their home areas and were housed in cyclone shelters while under quarantine. When the region was hit by Cyclone Amphan, many people, concerned over social distancing, hygiene and privacy, avoided the shelters and decided to weather the storm in unsecure locations. In the aftermath, there was a spike in COVID-19 cases, compounding the 100 fatalities directly caused by Amphan, which also caused damage in excess of 13 billion USD and displaced 4.9 million people.
- **Why is it happening?:** The new report identifies three root causes that affected most of the events in the analysis:
  - **Human-induced greenhouse gas emissions:** GHG emission is identified as one of the reasons why Texas experienced freezing temperatures, but these emissions also contribute to the formation of super cyclones such as Cyclone Amphan, on the other side of the world.
  - **Insufficient disaster risk management:** It was one of the reasons why Texas experienced such high losses of life and excessive infrastructure damage during the cold snap, and also contributed to the high losses caused by the Central Vietnam floods.
  - **Undervaluing environmental costs and benefits in decision-making:** The report also shows how the record rate of deforestation in the Amazon is linked to the high global demand for meat. This demand has led to an increase in the need for soy, which is used as animal feed for poultry. As a result, tracts of forest are being cut down.

## CONCLUSION

While nature's wrath may be inevitable, the human cost of disasters is not. As the world grapples with the ever-present threat of floods, earthquakes, and droughts, the need for effective preparedness measures becomes paramount. Investing in early warning systems, robust infrastructure, and resilient communities can turn the tide against disaster, reducing casualties and minimising economic damage. Embracing proactive risk management will be the key to unlocking a future where India not only coexists with hazards but thrives despite them.



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# Disaster Management Cycle

# 2

## INTRODUCTION

The Disaster Management Cycle, which has evolved since the **Yokohama Conference in 1994,** integrates both pre and post-disaster activities within a comprehensive framework, fostering a systematic approach. It recognizes prevention, mitigation, and preparedness as pre-disaster phases while highlighting the importance of response in the post-disaster period. Effective risk reduction and overall impact hinge on the optimal allocation of resources at each stage. This chapter will delve into all facets of the Disaster Management Cycle, exploring its various dimensions and components.

## STAGES IN DISASTER MANAGEMENT

The **conventional** disaster management approach prioritized **emergency relief and swift rehabilitation,** reflecting a compassionate state. The transition to a 'Welfare State' expands responsibilities, involving diverse entities in a comprehensive response to disaster factors throughout **pre-disaster, during the disaster, and post-disaster stages, ensuring proactive and effective management.**

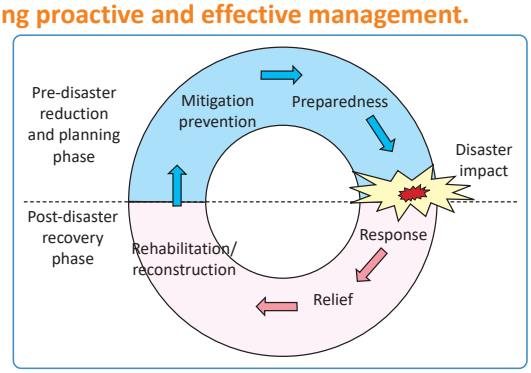


**Fig. 2.1:** Disaster Management Cycle

### Pre-Disaster: Prevention, Mitigation and Preparedness

- **Prevention:** Disaster prevention is the outright avoidance of adverse impacts of hazards and related disaster prevention through action taken in advance. Examples include dams or embankments that eliminate flood risks, land-use regulations that do not permit any settlement in high-risk zones, and seismic engineering designs that ensure the survival and function of a critical building in any likely earthquake.
- **Mitigation:** The Disaster Management Act 2005 has defined **mitigation as 'measures aimed at reducing the risk, impact, or effects of a disaster or threatening disaster situation',** but the Act has not defined prevention even though the term recurs at several places in the Act. In fact, the terms 'prevention' and 'mitigation' have been used interchangeably as very often the complete prevention or avoidance of losses in hazardous situations may not be feasible and the task transforms to that of mitigation. Prevention or mitigation are essentially ex-ante measures for reducing risks of disasters that would save lives in the long run, livelihoods and assets of rural and urban communities within the region/State
- **Preparedness:** This entails activities and measures taken in advance to ensure efficient response to the impact of the hazards, including the issuance of timely and effective early warnings, preparation of emergency plans and maintaining inventory.

### During Crisis: Emergency Response

When a crisis hits, the priority is to quickly respond to those affected to ease their suffering and minimize losses. During this phase, certain critical activities become crucial. These include evacuating people from danger zones, conducting search and rescue operations, and providing essential needs like food, clothing, shelter, medicines, and other necessities. The goal is to restore a sense of normalcy to the affected community's life as much as possible.

- **Effective Evacuation:** During the **Kerala Floods in 2018,** boats and helicopters played a crucial role in rescuing thousands of people. The key lesson learned is the **importance of local knowledge** and well-planned evacuations based on early warnings and understanding flood patterns.
- **Search and Rescue Expertise:** In the **Bhuj Earthquake of 2001**, the National Disaster Response Force (NDRF) and volunteers demonstrated dedication. This highlights the need for investing in trained personnel and specialized equipment for effective rescue operations.
- **Providing Essential Needs:** After the **Odisha Rail Accident in 2023,** community kitchens and volunteers ensured the quick mobilization of resources, minimizing suffering. The lesson here is the importance of community resilience in the aftermath of a disaster.
- **Swift and Coordinated Response:** The response to **Cyclone Phailin in 2013** involved a coordinated effort between the Navy, Air Force, and NDRF. This underscores the critical need for collaboration among government agencies, the military, NGOs, and local communities.
- **Restoring Normalcy:** Following the **Nepal Earthquake in 2015,** efforts focused on rebuilding villages and

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providing skill development programs. This emphasizes the importance of long-term recovery for a sustainable return to normalcy.

### Post Disaster

In this stage efforts shift towards rehabilitation and reconstruction to restore normalcy and ensure sustainable recovery:

- **Early Recovery and Risk Reduction:** In immediate disaster relief, focus on shelter, water, food, and medical care. Rescue, damage assessment, and debris clearance are key activities. Communication, institutional improvements, and recognizing voluntary efforts are critical for minimizing loss. Coordination across agencies is essential, akin to a war zone's success depends on effective communication.
- **Rehabilitation:** Rehabilitation restores normalcy for disaster victims through housing, infrastructure, and economic support. Lessons stress long-term strategies integrated into development. Personnel training is crucial, addressing specific concerns. In September **2022, Maharashtra** approved a policy for flood-affected village rehabilitation.
- **Reconstruction:** Reconstruction enhances communities by replacing structures, integrating safety measures, and incorporating indigenous knowledge. Socially, it promotes differentiated housing and open spaces, fostering "social capital" for effective recovery. The **Sendai Framework emphasizes "build back better"** in post-disaster reconstruction.

## ELEMENTS OF DISASTER MANAGEMENT

The three phases, encompassing preparedness and risk management, emergency response, and recovery and rehabilitation, can be further broken down into a variety of detailed activities.

- **Legal and Organizational Framework:** Establishing an appropriate legal and organizational framework is crucial for effective crisis management.
- **Risk Awareness and Communication:** Making government organizations, local bodies, communities, and individuals aware of potential hazards and vulnerabilities is essential for effective crisis preparedness.
- **Meticulous Planning and Implementation:** Detailed long and short-term planning, coupled with effective implementation and enforcement measures, forms a critical aspect of crisis management strategy.
- **Community Resilience and Participation:** Building resilience within communities to face crises and ensuring their active participation are key elements in crisis management.
- **Capability Building and Infrastructure Maintenance:** Developing and maintaining human and institutional capabilities, infrastructure, and logistics are vital for a robust crisis management system.
- **Knowledge Development and Dissemination:** Creating, disseminating, and applying knowledge is crucial for enhancing overall effectiveness in crisis management efforts.
- **Integration of Traditional Knowledge:** Incorporating traditional knowledge into crisis management efforts enhances the overall resilience and adaptability of communities in facing crises.

## A SHIFT TO DISASTER RISK REDUCTION

Historically, insufficient attention has been paid to disaster risk reduction (DRR) strategies, despite their potential to significantly reduce loss of life through the implementation of simple preventative measures. Comprehensive reviews of the global situation conducted in the aftermath of the **1994 Yokohama Declaration** revealed a concerning trend: economic losses attributable to natural disasters were steadily escalating. A lack of cohesive DRR strategies and the absence of a pervasive "culture of prevention" were identified as the primary drivers of this concerning phenomenon.

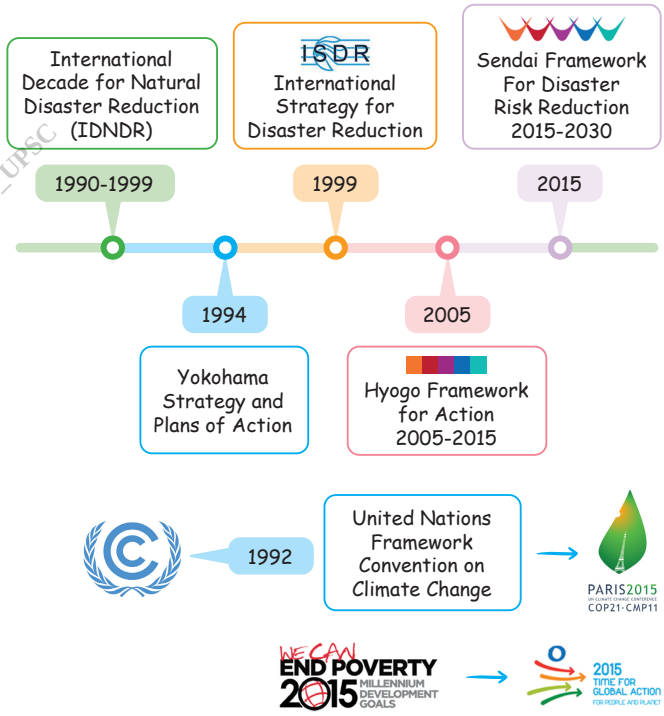


**Fig. 2.2:** Timeline of International Efforts towards DRR

- **Post-Yokohama Focus:** A paradigm shift occurred post-Yokohama, **integrating disaster mitigation into development policies, with principles emphasizing risk assessment, prevention, early warning, and international cooperation.**
- **Total Disaster Risk Management (TDRM):** The strategic objectives of the TDRM Approach, outlined in the 2001 Regional Workshop in Kathmandu by the Asian Disaster Reduction Centre (ADRC) and Office



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for the Coordination of Humanitarian Affairs (OCHA), Kobe, include:

- **Holistic Disaster Management:** Addressing concerns and gaps throughout the disaster management cycle by considering underlying causes of disasters and contextual factors in risk and its management.
- **The Yokohama Conference acted as a catalyst for the TDRM approach**. While the Conference laid out the broad principles, TDRM provided a more detailed and systematic framework for operationalizing those principles and putting them into practice.

**Fig. 2.3:** Total Disaster Risk Management (TDRM)

| SDG TARGETS RELATED TO DISASTER RISK REDUCTION | |
|---|---|
| **SDG Goal** | **Description** |
| Goal 1 | ❑ By 2030, enhance the resilience of the poor and vulnerable to climate-related extreme events and other economic, social, and environmental shocks and disasters. |
| Goal 2 | ❑ By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters that progressively improve land and soil quality. |
| Goal 3 | ❑ Strengthen the capacity of all countries, particularly developing countries, for early warning, risk reduction, and management of national and global health risks. |
| Goal 4 | ❑ By 2030, ensure all learners acquire knowledge and skills for sustainable development, including education for sustainable development, human rights, gender equality, and resilience to disasters. |
| Goal 6 | ❑ By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes. |
| Goal 9 | ❑ Develop quality, reliable infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable access for all.<br>❑ Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island development states. |



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| | |
|---|---|
| **Goal 11** | ❑ By 2030, significantly reduce the number of deaths, people affected, and economic losses caused by disasters, including water-related disasters, with a focus on protecting vulnerable populations.<br>❑ By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels. |
| **Goal 13** | ❑ Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries<br>❑ Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning |
| **Goal 14** | ❑ By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including strengthening their resilience, and taking action for their restoration in order to achieve healthy and productive oceans |
| **Goal 15** | ❑ Includes conservation, restoration, and sustainable use of terrestrial ecosystems, promoting sustainable forest management, combating desertification, restoring degraded land, and integrating biodiversity values into planning and development processes. |

## Developments in India

- **The Tenth Five-Year Plan (2002-2007):** The plan incorporates disaster preparedness, emphasizing the integration of disaster mitigation into sustainable development. It mandates each state to adopt a planning scheme for mitigation, institutionalizing it into developmental planning.
- **The Twelfth Finance Commission (2002):** Terms of Reference of the 12th FC included mitigation and prevention, expanding beyond its original focus on relief and rehabilitation.
- **Regulatory Role of the State:** The Disaster Management Act of 2005, establishes National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMAs), and District Disaster Management Authority (DDMAs), signaling a paradigm shift toward prevention, mitigation, and preparedness.
- **Holistic Approach:** The act emphasizes a proactive, integrated approach, shifting from relief-centric to prevention-oriented strategies, aiming to conserve developmental gains and minimize losses.

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## CONCLUSION

By navigating the Disaster Management Cycle, we transition from proactive mitigation to swift response and ultimately, towards holistic recovery. This cyclical journey strengthens preparedness, fosters community cohesion, and empowers long-term resilience. By embracing best practices and nurturing global collaboration, we emerge from disaster not merely repaired, but transformed, ready to rewrite the narrative of vulnerability into a testament to human ingenuity and unwavering hope.



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# Natural Hazards and Their Mitigation

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## INTRODUCTION

India has been vulnerable, in varying degrees, to a large number of natural, as well as, human-made disasters on account of its unique geo-climatic and socio-economic conditions. It is highly vulnerable to floods, droughts, cyclones, earthquakes, landslides, avalanches and forest fires. Out of 36 states and union territories in the country, 27 of them are disaster-prone.

According to the Ministry of Home Affairs (MoHA), the country's susceptibility includes nearly **85% of the landmass at risk of single or multiple disasters, 58.6% of the landmass prone to earthquakes, 12% (over 40 million hectares) to floods and river erosion, and 5,700 km of the coastline (nearly 8% of the total landmass) susceptible to cyclones and tsunamis.** Additionally, 68% of cultivable areas are vulnerable to drought, while Approximately 15% of our nation, spanning more than 0.49 million square kilometres, is susceptible to landslides. The Himalayan region, alluvial plains, hilly peninsula, and coastal zones each present specific challenges.

- For instance, **the Himalayan** region is prone to disasters like **earthquakes** and landslides; the Gangetic plains are affected by **floods** almost every year. The **desert** part of the country is affected by **droughts and famine** while the **coastal zone** is susceptible to **cyclones and storms.**
- **Global Data:**
  - **UNICEF Assessment:** According to UNICEF India is among the world's most worst disaster-prone countries, with risks stemming from adverse geo-climatic conditions, topography, environmental degradation, population growth, urbanisation, and non-scientific development.
  - **UNDRR Report Findings:** As per the UNDRR report India recorded 3rd highest number of natural disasters from 2000 to 2019.
  - **Regional Disparities:** The western part, including Rajasthan and Gujarat, frequently experiences droughts, and coastal regions are susceptible to cyclones and tsunamis due to oceanic disturbances.

## VARIOUS NATURAL HAZARDS AND THEIR MITIGATION

### Earthquake

According to the National Disaster Management Authority (NDMA), an **earthquake is an unpredictable phenomenon characterised by the sudden and violent shaking of the ground and everything on it.** Seismic activity in the Himalayan region stems from accumulated stress between the Indian and Eurasian plates, underscoring the importance of understanding geological dynamics for effective earthquake risk assessment and preparedness.

#### Causes of Earthquake

- **Plate Tectonics:** The outermost layer of the earth is not in one piece. It is fragmented. Each fragment is called a plate. The surface of the Earth is divided into 7 major plates and several minor ones. They move a few centimetres a year, riding on semi-molten layers of rock underneath the crust. As the plates move, they pull apart or collide, unleashing the powerful movements known as earthquakes.
  - There are **three types of plate boundaries.** These are **convergent** (plates coming together) **divergent** (plates moving apart), **transform** (plates moving past each other)
    - **Convergent boundaries:** When plates collide, one may be pushed under the other, creating subduction zones and **causing deep earthquakes.** Alternatively, they may buckle and crumple, forming mountain ranges and shallow earthquakes.
    - **Divergent boundaries:** When plates move apart, new crust forms at mid-ocean ridges, producing shallow earthquakes and volcanic activity.
    - **Transform boundaries:** When plates grind past each other sideways, friction builds up, releasing stress in frequent, shallow earthquakes along fault lines.
- **Other Causes:** Tremors on the earth can also be caused when a **volcano erupts, a meteor hits the earth, or an underground nuclear explosion** is carried out. For example, A 6.3 magnitude earthquake shook North Korea after the country launched its biggest nuclear test.

#### Earthquake Swarm

**Definition:** A swarm is a sequence of mostly small earthquakes with no identifiable mainshock. Swarms are usually short-lived, but they can continue for days, weeks, or sometimes even months. They often recur at the same locations. Most swarms are associated with geothermal activity.

**Palghar Swarm:** In 2018, the first earthquake in the series, with a rumbling sound, was detected near the village Dhundhalwadi in the Palghar district of Maharashtra. Since then more than 16,000 earthquakes of magnitude 0.5 to 3.8 have occurred till 2020. Palghar is non-tectonic and non-volcanic in nature and experts concluded that these tremors were caused by intense rainfall.

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## Earthquake Risk in India

- **Geographical Vulnerability:**
  - The **Himalayas** - the youngest among the mountain ranges - are still evolving and adjusting to tectonic movements; **the existence of two major fault lines located on its west and east**, has resulted in very severe earthquakes in several parts of the Himalayan and surrounding regions. This makes the entire region covering fourteen states (located in western and central Himalayas, northeast, and parts of the Indo-Gangetic basin) highly prone to earthquakes.
  - The **tectonic features** and characteristics of the Himalayas are extended to **the alluvial plains of Indus, Ganga and Brahmaputra** too, as the rocks lying below the alluvial plains are just extensions of the Himalayan ranges only.

**Seismic Zones In India As Per The Bureau of Indian Standards**

| Zones | Description |
|---|---|
| Zone V | Most seismically active, including the **entire of North-eastern India,** parts of Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Rann-of-Kutch in Gujarat, parts of North Bihar, and Andaman & Nicobar Islands. |
| Zone IV | Encompasses the remaining parts of Jammu and Kashmir, Himachal Pradesh, Delhi-NCR region, Sikkim, northern parts of Uttar Pradesh, Bihar, West Bengal, parts of Gujarat, and small portions of Maharashtra near the west coast and Rajasthan. |
| Zone III | Includes Goa, Kerala, Lakshadweep, remaining parts of Uttar Pradesh, Gujarat, West Bengal, parts of Punjab, Rajasthan, Madhya Pradesh, Bihar, Jharkhand, Chhattisgarh, Maharashtra, Orissa, Andhra Pradesh, Tamil Nadu, and Karnataka. |
| Zone II | The least active seismic zone, covering the remaining portion of the country. |
| Zone I | There are no cities in India which fall under Seismic Zone I |

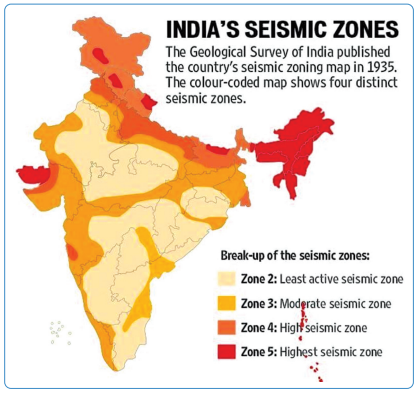


**Fig. 3.1:** Seismic Zones And Intensity Map of India

### Delhi's Earthquake Susceptibility

Delhi is located in **zone IV** which has **fairly high seismicity** where the **general occurrence of earthquakes is of 5-6 magnitude, a few of magnitude 6-7 and occasionally of 7-8 magnitude.** Delhi thus lies among the high-risk areas. Seismicity in North India, including the Himalayas, is **due to collision of the Indian plate with Eurasian plate**. Two major lineaments namely **Delhi-Haridwar ridge and Delhi-Moradabad faults pass through the territory,** which having the potential of generating earthquakes of magnitude upto MSK VIII.

## The Impact of Earthquakes

- **Human Loss:** According to a report compiled by UNDRR, between 1998 and 2017, approximately 56% of the total deaths, accounting for 747,234 lives in the world, were attributed to earthquakes and related tsunamis. As per data on NDMA Website during the last 15 years, India has experienced 10 major earthquakes that have resulted in over 20,000 deaths.
- **Structural Damage:** According to the World Bank Earthquakes contribute to about 18% of infrastructure damage globally.

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- **Economic Impact:** The World Bank estimated the **total loss of public and private property from the Gujarat earthquake of 2001 to be 4.97 billion USD**, constituting approximately 1% of India's GDP. In Latur earthquake (1993) and the Sikkim earthquake(2011) the loss percentages are 0.13% and 0.13% of GDP of India respectively.
- **Associated Hazards:** Earthquakes may trigger landslides and mudslides, particularly in areas with water-soaked soils, exemplified by incidents like the Malin village **landslide** in Maharashtra (2014) and the Kedarnath landslide in Uttarakhand (2023). Along with this Earthquakes, especially those originating on the ocean floor, can generate large **tsunamis**, as witnessed in the devastating 2004 Indian Ocean earthquake and tsunami.
- **Liquefaction:** The shaking during an earthquake can transform loose soil into a liquid, posing additional hazards.



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- **Fires:** Displacement of electrical and gas lines during an earthquake can lead to fires, adding to the overall impact on human health, property, and infrastructure.
- **Comparison with Other Countries:** Unlike countries with robust structural mitigation measures, high-intensity earthquakes in India lead to substantial loss of life due to the fragile nature of structures.

### Steps Taken by the Indian Government

- **Earthquake Hazard Zonation Map:** This map divides India into four seismic zones (II-V) depending on the severity of ground shaking expected during earthquakes. Zone V is the most seismically active, whereas Zone II is the least active.
  - Approximately 11% of the country is in zone V, 18% in zone IV, 30% in zone III, and the remainder in zone II.
- **The National Centre for Seismology**, under the Ministry of Earth Sciences, is the Government of India's (GoI) primary institution for monitoring earthquakes in and around the country.
  - NCS operates a **National Seismological Network (NSN)** comprising 153 observatories across the country for this purpose. A seismic **microzonation of Indian cities** with 5 Lakh or more population is also considered.
- **National Earthquake Risk Mitigation Project (Preparatory Phase)**
  - It is a Centrally Sponsored Plan Scheme of coordination with the State Governments which lie in seismic zones IV and V.
  - Major components of the project are adoption and updation of Techno - legal Regime in concerned Cities/ States, institutional **strengthening, capacity building of practising architects, engineers and masons in earthquake resistant constructions and public awareness and the sensitization at National level and all vulnerable States.**
- **National Building Code (1970):** NBC formulated by BIS, provides extensive guidelines governing building construction, encompassing materials, planning, and design with the primary goal of ensuring public safety by addressing structural sufficiency, fire hazards, and health aspects in buildings. NBC plays a crucial role in standardising construction practices to elevate safety standards.

### Challenges for Earthquake Mitigation in India

- **Inadequate Enforcement:** Weak enforcement of earthquake-resistant building codes and town planning by-laws contributes to structural vulnerabilities. **Non-compliance with ductile design standards outlined in IS 13920, 1993 for structures in high seismic regions is a serious concern.**
- **Missing Resilient Features:** Many constructions in both urban and rural areas lack essential earthquake-resistant features, exacerbating risks.
- **Professional Training Gap:** Inadequate formal training in earthquake-resistant construction practices, as per BIS guidelines, poses a hindrance to effective safety measures among professionals.
- **Limited Preparedness:** Poor preparedness and response capacity among various stakeholder groups pose challenges in effectively addressing earthquakes.
- **Low Awareness:** Lack of awareness about seismic risks among stakeholders further impedes mitigation efforts.
- **Licensing Gaps:** The absence of well-implemented licensing systems for engineers and masons contributes to non-standardized practices in construction, compromising quality, safety, and efficiency in the industry.

### Way Forward

- **Seismic safety techniques for buildings:** Seismic safety aims to prevent casualties and injuries caused by buildings by establishing techniques that minimise damage to constructions. Example: **Techniques like hydraulic wall and shaking table tests** that measure compressive, shear, and tensile strength, structural testing.
- **Microzonation:** Dividing earthquake-prone regions into smaller zones with similar hazard levels can help tailor building codes and mitigation strategies to specific risks and vulnerabilities. This can lead to more cost-effective and targeted interventions.
- **Learning from past experiences**: The mitigation plans developed by Maharashtra and Gujarat after the Latur and Bhuj earthquakes provide valuable lessons and best practices that can be adapted and implemented in other vulnerable states. Sharing knowledge and expertise across different regions can strengthen India's overall preparedness.
- **Guidelines of NDMA on Earthquake Management (2007)**
  - **Earthquake Resistant Construction:** Central ministries, departments, and state governments are instructed to promote the implementation of relevant standards for seismically safe design and construction of buildings, bridges, ports, flyovers, harbours, and other vital structures under their control.
  - **Structures and Lifeline Structures:** Programs for seismic strengthening of priority structures, such as Raj Bhavans, legislatures, courts, academic institutions, reservoirs, dams, and multi-storeyed buildings, should be developed by central ministries and state governments.
  - **Regulation and Enforcement:** State governments are responsible for specifying mechanisms to implement Building Codes and safety codes, ensuring compliance with seismic safety in all design and construction activities. Modifications to town and country planning

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Acts, land use regulations, zoning regulations, DCRs, and building bylaws are recommended to align with globally accepted norms.

- **Awareness measures:** Sensitization of stakeholders is crucial for earthquake preparedness and mitigation. The guidelines recommend the preparation of handbooks on earthquake safety, homeowner's seismic safety manuals, structural safety audit manuals, and video films for the general public. The creation of vulnerability maps and streamlining of NGOs and volunteer groups is also emphasised.
- **Capacity Development (Education, Training, R&D, Capacity Building and Documentation):** Target groups for capacity development include elected representatives, government officials, media professionals, urban planners, engineers, architects, builders, NGOs, community-based organisations, social activists, social scientists, school teachers,, and school children.
- **Emergency Response:** The Response activities are coordinated through the **Incident Command System**, led by local administration through the Emergency Operations Centre network. It involves community participation, collaboration with the corporate sector, and specialised teams.

### Case Study- Earthquake Mitigation: The Japan Way

Japan was struck by a powerful 7.6 magnitude earthquake on 1 January 2024. **Approximately 155 quakes have since shaken the country,** resulting in damage to roads, buildings, and widespread power outages. The death toll has been estimated to be at least 48.

**Japan's Proneness:** Japan accounts for about 20 percent of the world's earthquakes of magnitude 6 or greater, and each year experiences up to 2,000 quakes that c an be felt by people. Sitting amidst the "Pacific Ring of Fire," Japan grapples with the interactions of three significant tectonic plates, including the Pacific Plate beneath the Pacific Ocean and the Philippine Sea Plate. Positioned at this geological crossroads, the **country becomes a focal point for the dynamic forces resulting from the continuous shifts in these substantial plates.**

#### Preparedness

- **Infrastructure: Japan's strict building codes** ensure that every home is constructed to endure seismic activity and its sophisticated early warning system provides crucial seconds to minutes of advance notice before strong shaking. **Older buildings and critical infrastructure undergo retrofitting** to meet current seismic standards.
- **Transport**: Trains are also made earthquake resistant with seismic sensors installed to trigger a nationwide halt in the event of an earthquake, guaranteeing passenger safety.
- **Two primary resilience levels:** First aims to **endure smaller earthquakes**, typically experienced three or four times during a building's lifespan in Japan. At this level, any **damage requiring repair is deemed unacceptable;** the design should ensure the building remains undamaged. The **second resilience level involves withstanding rare, extreme earthquakes.**
- **Drill and Training:** From a young age, every child learns emergency procedures through **drills and is aware of the protocol in emergency situations.**
- **Coastal safety:** Given Japan's susceptibility to tsunamis triggered by earthquakes, the country has implemented coastal barriers and warning systems to protect coastal areas. These systems include **seawalls and early warning systems to evacuate residents.**

**Impact:** Last year, a 7.8 magnitude earthquake hit south-east Turkey near the Syrian border, killing over 50,000 people and causing extensive destruction. **In comparison, the death toll in Japan has been estimated to be 48 only.**

### Quake Smart System - Early Warning in San Francisco

San Francisco sits in the proximity to San Andreas Fault, making it one of the most earthquake-prone cities in the world. The Quake Smart System (aka ShakeAlert) is being piloted in San Francisco to assess its effectiveness in mitigating the impact of future earthquakes.

**Deployment:** Around **500 sensors were installed across the city in critical infrastructure locations** (bridges, buildings, schools, hospitals) and strategic geodetic points along with Real-time data transmission to a central processing unit located at a secure facility outside the city centre.

#### Functionality

- **Early Warning Algorithm:** Advanced algorithms analyze sensor data to detect early signs of seismic activity, including P-waves (faster seismic waves) preceding the destructive S-waves (slower, shaking waves).
- **Warning Dissemination:** Alerts are issued through various channels such as Public loudspeakers and mobile phone notifications. Integration with traffic light systems to prioritise emergency vehicle movement.

#### Potential Benefits

- **Saving Lives:** Early warnings can enable people to take protective actions like dropping, covering, and holding, potentially reducing injuries and fatalities.
- **Protecting Infrastructure:** Critical infrastructure like hospitals, power plants, and transportation systems can be shut down or secured in advance, minimising damage and ensuring quicker recovery.
- **Emergency Response Coordination:** Emergency responders can be mobilised and pre-positioned closer to affected areas, leading to faster and more effective rescue efforts.

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## TSUNAMI

Tsunami are a series of waves usually generated by the movement of the sea floor. These movements are caused by different types of geophysical phenomena such as earthquakes, landslides and volcanic eruptions. The name tsunami was derived from the Japanese term meaning 'harbour' wave.

### Causes of Tsunami

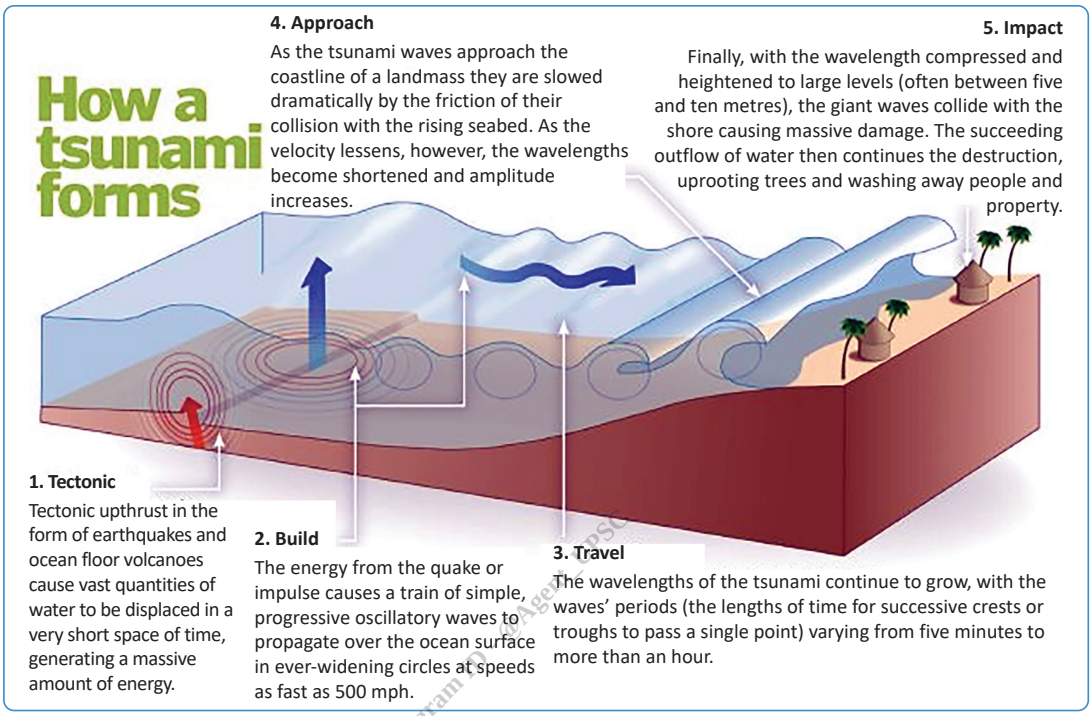


**Fig. 3.2:** Formation of Tsunami

- **Earthquakes:** All earthquakes do not cause tsunamis. There are four conditions necessary for an earthquake to cause a tsunami:
  - Must occur beneath the ocean or cause the material to slide into the ocean.
  - Must be strong, at least magnitude 6.5 on the Richter Scale
  - The earthquake must rupture the Earth's surface and it must occur at a shallow depth – less than 70 km below the surface of the Earth.
  - The earthquake must cause vertical movement of the seafloor (up to several metres).
- **Landslide:** A landslide that occurs along the coast can force large amounts of water into the sea, disturbing the water and generate a tsunami. Underwater landslides can also result in tsunamis when the material loosened by the landslide moves violently, pushing the water in front of it.

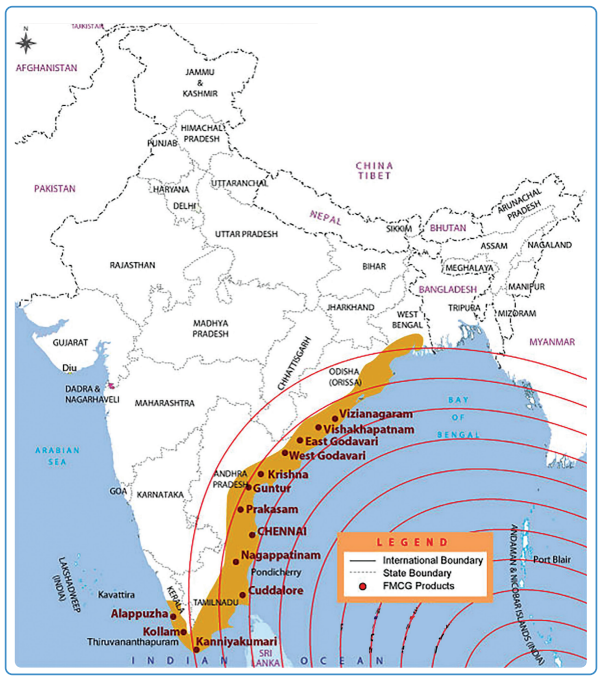


**Fig. 3.3:** Tsunami Affected Areas in India



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**Volcanic Eruption:** Although relatively infrequent, violent volcanic eruptions also represent impulsive disturbances, which can displace a great volume of water and generate extremely destructive tsunami waves in the immediate source area. According to this mechanism, waves may be generated by the sudden displacement of water caused by a volcanic explosion, by a volcano's slope failure, or more likely by a phreatomagmatic explosion and collapse/engulfment of the volcanic magmatic chambers.

- **Extraterrestrial collision** (i.e. asteroids, meteors):Although no meteor/asteroid induced tsunami has been recorded in recent history, scientists claim that if these celestial bodies should strike the ocean, a large volume of water would undoubtedly be displaced to cause a tsunami.

### Tsunami Risks in India

- **Vulnerability:** Both the East and West coasts of India, with over 2200 km of heavily populated shoreline, are susceptible to tsunami waves.
- **Climate Change:** Rising sea levels not only make coastal communities more vulnerable to flooding from storms but also tsunamis. Even modest rises in sea level will dramatically increase the frequency and intensity of flooding when a tsunami occurs, as the tsunami can travel further inland.
- **Historical Incidents:** According to the ICMAM-PD report 2005, in the last 300 years, the Indian Ocean region has experienced 13 tsunamis, with 3 occurring in the Andaman and Nicobar region.

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### 2004 Tsunami

On 26th December 2004, the Indian ocean was struck by a massive earthquake and tsunami which killed 230,000 people and caused widespread destruction. **Triggered by the undersea earthquake activity offshore, the 100-feet-high tsunami waves laid bare complete annihilation in as many as 14 countries, making it one of the deadliest natural disasters in recorded history.** According to geological estimates, the 2004 earthquake was the third-largest of its type to ever be recorded, and it managed to even trigger aftershocks as far away as in Alaska.

### Impact of Tsunami

- **Coastal Devastation:** The 2004 Indian Ocean event caused widespread destruction along the coasts of Indonesia, Thailand, Sri Lanka, and India, resulting in the loss of human lives and damage to infrastructure.
- **Economic Loss:** The 2011 Tōhoku event resulted in billions of dollars in economic losses, including damage to industries, ports, and transportation networks.
- **Loss of Life:** The 2004 Indian Ocean event led to the tragic loss of over 230,000 lives across multiple countries.
- **Environmental Impact:** The 2011 Tōhoku event in Japan damaged ecosystems and led to the release of pollutants, affecting marine life and coastal environments.
- **Secondary Effects:** Tsunamis, as well as other secondary effects of natural disasters, can lead to subsequent disasters, such as fires, landslides, and health crises, compounding the overall impact.

### Steps taken by the Indian government

- **Indian Tsunami Early Warning System (ITEWS):** It was established in **2007** and operated by **INCOIS** in Hyderabad. ITEWS utilises a real-time network of seismic stations and tide gauges, operating 24X7, to detect tsunamigenic earthquakes, monitor tsunamis, and provide timely advisories to vulnerable communities. It is **Accredited by the Intergovernmental Oceanographic Commission (IOC) of UNESCO**, ITEWS has served as a Tsunami Service Provider for 28 Indian Ocean Rim countries, along with Indonesia and Australia, since 2011, issuing regional warnings.
- **Indian National Centre for Ocean Information Services (INCOIS):** Established in 1999 under the Ministry of Earth Sciences, INCOIS operates as an autonomous body. Serving as the nodal agency through the Indian Tsunami Early Warning Centre (ITEWC), INCOIS provides tsunami advisories to India and collaborates with Disaster Management Officials for the Tsunami Ready program. Additionally, it conducts biannual IOWave Tsunami mock exercises, enhancing preparedness and coordination with stakeholders for emergency situations.

### Post 2004 Development in Tsunami Mitigation

- **Better Prediction:** By the 2000s, advances had been **made in earth observations, computer modelling of hazards and telecommunications.** Electronic sensors were developed that could rapidly detect earthquake shaking on land and tsunami waves at sea. For instance, the **United States developed the Deep-ocean assessment and Reporting of tsunamis system, known as DART II.**
- **Collaboration:** In less than three months following the devastating Indian ocean tsunami, **scientists worked together with policymakers to form an international commitment to develop an Indian ocean tsunami Warning System**
- **Policy frameworks:** Indonesia, Sri lanka and India developed new disaster management policy frameworks, governance structures and plans to address tsunami and other natural disaster risks. For instance, the **Indonesian Government developed the presidential tsunami Master plan**.



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Regional Integrated Multi-Hazard Early Warning System (RIMES), established in 2009 after the 2004 Indian Ocean tsunami, is an intergovernmental institution focused on building capacities for early warning systems. Operating from Thailand, it supports member states in monitoring, forecasting, and assessing risks from various hazards. RIMES enhances data availability, improves modeling and forecasting, transforms data into actionable information, and builds capacity for climate and disaster resilience. It fosters partnerships for data sharing and research, aiming to create tailored services for decision-making. Through community engagement and capacity building, RIMES strives to create a more resilient region against natural disasters

## Challenges in Tsunami Risk Management in India

- **Limited Documentation and Paleo-Tsunami Studies:** Lack of easily accessible tsunami documentation and paleo-tsunami studies impedes a comprehensive understanding of past events for improved risk assessment.
- **Insufficient Bathymetric (underwater topography) and Topographic Data:** Inadequate high-resolution near-shore bathymetric and topographic data pose limitations for developing accurate inundation models.
- **Community Awareness Gap:** Inadequate awareness among coastal communities about tsunami risk and vulnerability hinders effective preparedness.
- **People's Participation Deficiency:** Lack of active involvement and participation from the public in enhancing disaster preparedness, mitigation, and emergency response in coastal areas.
- **Underutilization of Traditional Knowledge:** The absence of systematic documentation of traditional knowledge related to tsunami risk management prevents the incorporation of valuable insights from local communities.

## Way Forward

- **Developing innovative mitigation technologies:** Exploring new materials, construction techniques, and early warning tools can further strengthen India's defences against tsunamis.
  - **Tree Plantation:** One of the natural measures to reduce the impact of tsunamis is using **shoreline tree cover.** For example, the **village of Naluvedapathy in Tamil Nadu** region faced minimal damage and few deaths because of the forest of 80, 244 trees planted along the shoreline in 2002.
- **Expanding the reach of ITEWC:** By establishing additional monitoring stations and bolstering data analysis capabilities, ITEWC can provide even more accurate and timely warnings to a wider range of coastal communities.
- **Enhancing public awareness programs:** Continued community engagement through drills, educational campaigns, and localised advisories is essential to keep tsunami safety at the forefront of public consciousness.
- **Coastal protection infrastructure:** Strategically developing seawalls, breakwaters, and mangrove restoration projects can offer valuable barriers against tsunami waves, protecting vulnerable communities and critical infrastructure.

## NDMA Guidelines on Management of Tsunamis in India

- **Risk Assessment and Vulnerability Analysis**
  - Recommend **vulnerability assessment and risk mapping** based on coastal land use and bathymetry.
  - Develop **models for estimating tsunami** wave arrival and run-up height.
  - Utilise the **Indian Naval Hydrographic Department** for bathymetry information.
- **Tsunami Preparedness**
  - Establish a **Real-Time Seismic Monitoring Network (RTSMN)** and use Bottom Pressure Recorders (BPRs) for wave detection.
  - Implement the **National Data Buoy Programme** for buoy protection.
  - Set up Tsunami Bulletins, warning systems, and **"Tsunami Escape"** signboards in coastal areas.
  - Conduct public awareness campaigns through visual and radio media.
- **Structural Mitigation Measures**
  - Construct cyclone shelters, submerged sand barriers, sand dunes with vegetation, and mangrove plantations.
  - Develop a network of **local knowledge centres** for training and emergency communication.
  - Build location-specific sea walls, coral reefs, breakwaters, and a **"Bio-Shield"** along the coastline.
  - Retrofit vulnerable structures for tsunami and cyclone resistance.
- **Regulation and Enforcement**
  - Strictly enforce **coastal zone regulations** within 500 m of the high tide line.
  - Adopt a **model techno-legal framework** for compliance with tsunami-safe zoning and construction practices.
- **Emergency Tsunami Response**
  - Involve community groups in search and rescue operations.
  - Deploy boats, helicopters, and search & rescue equipment immediately after a tsunami.

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- **Ensuring Implementation**
  - Focus on **aggressive capacity building** for local communities and administration.
  - Conduct **awareness and training programs** for fishermen, coast guards, fisheries officials, and port authorities.
  - Regularly test the efficacy of disaster management plans through drills.

## Floods

Floods are the second-most widespread natural disaster on Earth, after wildfires. It can develop in many ways. The most common is when rivers or streams overflow their banks. These floods are called riverine floods. Heavy rain, a broken dam, rapid ice melt in the mountains, or even a beaver dam in a vulnerable spot can overwhelm a river and send it spreading over nearby land. The land surrounding a river is called a floodplain. Coastal flooding, also called estuarine flooding, happens when a large storm or tsunami causes the sea to rush inland.

### Causes of Flood

- **Heavy rainfall:** This is the most common cause of flooding, especially in areas that can't absorb the water quickly. Prolonged or intense rainfall can overwhelm drainage systems and rivers, causing them to overflow their banks.
- **Rapid snowmelt:** When snow melts quickly, due to warm temperatures or heavy rain, it can release a large amount of water that can overwhelm rivers and drainage systems.
- **Storm surges:** Coastal areas are vulnerable to flooding from storm surges, which are high waves caused by hurricanes and other storms. Storm surges can inundate low-lying areas, causing significant damage.
- **Tsunamis:** Tsunamis, which are large waves caused by underwater earthquakes or volcanic eruptions, can also cause flooding in coastal areas.
- **Ice jams:** When ice builds up in rivers and streams, it can create blockages that cause water to back up and flood surrounding areas.
- **Anthropogenic reasons:** Forests act like sponges, absorbing and slowly releasing rainwater. When trees are cut down, the land becomes less able to absorb water, increasing the risk of flooding. Apart from this poor land management and Human induced Climate change also instigate floods.

### Risk of Floods in India

- **The extent of Flood Prone Areas:** According to the National Flood Commission, floods impact 25 out of 36 states and union territories in India, affecting around 40 million hectares of land, which is roughly one-eighth of the country's geographical area.
- **India's Flood Prone Nature:** India is among the most flood-prone countries globally, primarily due to its **natural ecological systems, including the monsoon, highly silted river systems, and erodible mountains,** especially in the Himalayan ranges. Most floods coincide with the monsoon period, associated with tropical storms, active monsoons, and break monsoon situations.

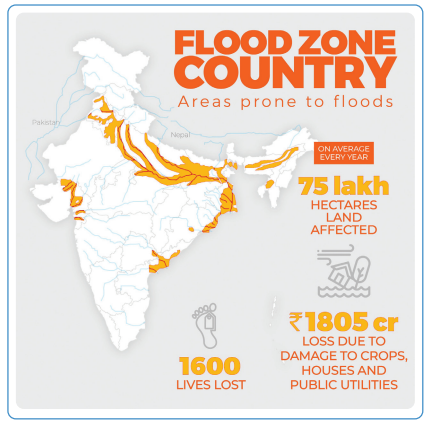


**Fig. 3.4:** Major Flood Zones In India

- **India's Flood-Prone Regions**
  - **Brahmaputra Region:** Faces monsoon rainfall, erosion-prone hills, earthquakes, and flash floods.
  - **Ganga Region:** Tributary floods, north-side damage, increasing west to east and south-to-north, encroachment issues.
  - **North-West Rivers:** Indus, Sutlej, Beas, etc. - fewer flood issues, drainage inadequacies, water-logging from irrigation and development.
  - **Central and Deccan India:** Stable rivers, occasional floods in Orissa, coastal concerns during monsoons and cyclones.

### Impact of Flood

- **Economic Damage:** According to NDMA website the average annual flood damage in the last 10 years period from 1996 to 2005 was Rs. 4745 crore as compared to Rs. 1805 crore, the corresponding average for the previous 53 years. This can be attributed to many reasons including a steep increase in population, rapid urbanisation, growing developmental and economic activities in flood plains coupled with global warming.
- **Loss of lives:** On average every year, 75 lakh hectares of land is affected, 1600 lives are lost and the damage caused to crops, houses and public utilities is Rs.1805 crores due to floods. The maximum number of lives (11,316) was lost in the year 1977. The frequency of major floods is more than once in five years (NDMA Website).
- **Social impact:** Floods can displace millions of people, forcing them to leave their homes and livelihoods behind. They can also lead to the spread of waterborne diseases, such as cholera and typhoid. Floods can also have a long-term impact on mental health, causing anxiety, depression, and post-traumatic stress disorder.

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### Constitutional Provisions Related to Floods in India

Flood control is not explicitly listed in the 7th Schedule of the Indian Constitution, unlike irrigation. However, "Drainage and Embankments" are specifically mentioned in Entry 17 of List II (State List), highlighting water-related measures. The Union List (List I, Entry 56) emphasises the Union government's role in regulating inter-state rivers and valleys, but the primary responsibility for flood control rests with the states.

### Sikkim Floods: A Case Study

In October 2023, heavy rains triggered a glacial lake outburst flood in Sikkim, India, as the **South Lhonak Lake** breached its banks, destroying the Teesta III Dam at Chungthang and causing widespread damage downstream. The event, the deadliest in the region since the 1968 Sikkim floods, resulted from increased lake size due to glacial retreat. Despite ongoing relief efforts, the flood impacted multiple districts, leading to evacuations, infrastructure damage, and the mobilisation of the National Disaster Response Force and the Indian Army for rescue operations.

### Steps Taken by the Government

- **Flood Hazard Zonation Map:** Flood Plain Zoning is an effective non-structural flood management tool. Flood-plain zoning measures demarcate regions likely to be affected by floods of varied magnitudes, frequency, and likelihood levels and prescribe the types of permissible developments in these zones to reduce damage when floods occur.
  - **Central Water Commission (CWC):** It provides short-term flood forecasting using a statistical methodology (gauge-to-gauge correlation). CWC presently issues flood forecasts for 338 forecasting stations (138 Inflow Forecast Stations & 200 Level Forecast Stations) which include 25 States and UTs.
- **National Flood Risk Mitigation Project (NFRMP):** NFRMP has been envisaged for mitigation or reduction in risk, severity or consequences of floods. It aims to ensure that arrangements are in place to mobilise the resources and capability for relief, rehabilitation, reconstruction and recovery from disasters besides creating awareness among vulnerable communities. NDMA has been entrusted to prepare a Detailed Project Report (DPR) on the Flood Risk Mitigation Project.
- **Flood Management Program:** Under the Programme, central assistance was provided to State Governments for taking up works related to river management, flood control, anti-erosion, drainage development, flood proofing, restoration of damaged flood management works and anti-sea erosion. The scheme since its inception has undergone several changes as per demands of states/UTs and also on account of various directions and policies of Govt. of India.
- **iFLOWS:** It is a collaboration for monitoring and flood warning systems, between the Ministry of Earth Sciences (MoES) and the Brihanmumbai Municipal Corporation (BMC)). It will be able to send out warnings of potential flood-prone locations anywhere from 6 to 72 hours in advance.

### Way Forward

**Geological Survey of India's recommendation on flood Control:** GSI studied the shape and material of the land getting inundated and generated data on area, shape, slope, infiltration and permeability of soil of the basin, drainage pattern, landform and longitudinal and cross profiles of the channels. On the basis of these studies, GSI produces flood hazard maps indicating prohibitive, Restricted, Cautionary and Flood Free Zones.

### Significant Flood-Related Studies and Recommendations Made by GSI are as Follows

- **Brahmaputra Valley:** A comprehensive geo-environmental database for environmental management and flood control generated in the studies.
- **Lower Banas sub-basin:** Selective irrigation to prevent the rise of groundwater table is recommended.
- **Kandi Basin West Bengal:** GSI recommended the construction of small weirs to reduce the impact of floods.
- **Mokameh Tal area in the Ganga Flood Plain:** Rejuvenation of existing drainage channels to reduce flood problem
- **Lower Damodar Basin:** Diversion along artificial canals and re-excavation of old river channels.
- Landslide zonation map for Himalayan region.

### NDMA Guidelines on Flood Management in India (2008)

- **Observation Networks and Early Warning**
  - Preparation of flood vulnerability maps.
  - Assistance to states/UTs in identifying priority flood protection and drainage improvement works.
  - Monitoring flood preparedness, river basin, and reservoir management plans.
  - Real-time collection of hydro-meteorological data on key rivers, including those from Nepal, Bhutan, and China.
  - Developing, improving, and updating flood forecasting methods and models for inflow quantification and dam storage.
- **Zoning, Mapping, and Classification**
  - Preparation of large-scale hazard maps to identify high-vulnerability zones.

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- Enactment and enforcement of floodplain zoning regulations by state governments.

❑ **Research and Development**
- Scientific study by the Central Water Commission (CWC) and state governments on river bed rise and exploration of desilting/dredging viability.
- Evolution of shelter designs in flood-prone areas.
- River basin studies and research on flood-related problems.
- Hydrological and morphological studies before major flood control or prevention measures.

❑ **Dissemination of Warnings and Information**
- Real-time data exchange and collaboration with Nepal, Bhutan, and China for flood forecasting.
- Quick, clear, and effective dissemination among central and state agencies.
- Distribution of necessary communication equipment and last-mile connectivity.
- Warning systems using various media.
- Interface with mobile network service providers for warnings.

❑ **Inter-Agency Coordination**
- Effective coordination and seamless communication among central and state agencies.
- Strengthening of Ganga Flood Control Board and Brahmaputra Board.

❑ **Structural Measures**
- Implementing flood risk reduction measures involves constructing embankments, flood walls, and levees based on hydrological studies.
- Coastal states and port authorities plan sea walls, and prioritising proper alignment of waterways, drainage systems, dam safety, desilting rivers, and hazard-resistant infrastructure construction enhances overall resilience to floods.

❑ **Awareness Generation**
- Mass media and community campaigns foster a culture of disaster risk management, promoting attitude and behaviour change.
- Strengthened civil society networks, insurance promotion, and counselling teams with diverse expertise to enhance awareness and resilience in disaster risk reduction and management.

❑ **Mock Drills or Exercises:** Promotion and execution of emergency drills by all ministries and States/UTs.

❑ **Vocational Training/Skill Development:** Promotion of skill development for multi-hazard-resistant construction in flood-prone areas for different types of housing and infrastructure.

❑ **Empowering Women and Marginalised Communities:** Incorporating gender-sensitive and equitable approaches in capacity development covering all aspects of disaster management.

❑ **Community-Based Disaster Management**
- Training for PRI, SHG, NCC, NSS, youth, and local community organisations.
- Strengthening the community's ability to manage and cope with disasters based on a multi-hazard approach

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### Case Study- York, USA

**Problem:** York, a historic city situated at the confluence of the Rivers Ouse and Foss, has a long and complex relationship with flooding. Rising water levels have threatened the city for centuries, with devastating consequences such as the Boxing Day floods of 2015. However, York's response to flood management is a prime example of a dynamic and multifaceted approach that prioritises protection, preparedness, and resilience.

#### The Challenges

❑ **Geography:** York's low-lying position and the convergence of rivers make it naturally susceptible to flooding.

❑ **Climate Change:** Increased rainfall and storm intensity due to climate change are predicted to exacerbate flooding risks.

❑ **Historic Infrastructure:** The city's mediaeval walls and narrow streets present unique challenges for implementing flood defences.

**The Solutions:** York's flood management strategy combines **traditional hard engineering with innovative methods and community engagement, which includes:**

❑ **Embankments:** Raised embankments along the riverbanks provide the first line of defence against rising water.

❑ **Foss Barrier:** A movable barrier across the River Foss prevents backflow into the city center.

❑ **Sluice Gates:** These gates control the flow of water within the river system, diverting excess water during floods.

❑ **Clifton Ings:** This designated floodplain allows controlled flooding, storing excess water and reducing pressure on the city center.

❑ **Floodplain Restoration:** Projects are underway to restore natural floodplains and wetlands, enhancing their capacity to absorb floodwaters.

❑ **Flood Awareness Campaigns:** Educational programs help residents understand flood risks and prepare for emergencies.

## Urban Floods

Urban flooding refers to flooding incidents that occur in urban areas, characterised by excessive runoff due to overloaded



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drainage systems and unregulated construction. This phenomenon has been on the rise in India in recent years, posing challenges for urban planning and infrastructure management.

### How Urban Flooding is Different From Riverine Flooding?

Urban catchment development intensifies floods (1.8 to 8 times) and volumes (up to 6 times) compared to rural areas. Rapid urban flooding occurs within minutes, exacerbated by high population density, elevating vulnerability and infection exposure. The impact on critical infrastructure in urban zones magnifies economic losses and disrupts essential services.

### Causes of Urban Floods

**Natural Factors Contributing to Urban Flooding**

| Meteorological Factors | Hydrological Factors |
|---|---|
| ❑ Rainfall<br>❑ Cyclonic storms<br>❑ Small-scale storms<br>❑ Temperature<br>❑ Snowfall and snowmelt | ❑ Soil moisture level<br>❑ Groundwater Level Prior to storm<br>❑ Natural surface infiltration rate<br>❑ Presence of impervious cover<br>❑ Channel cross-sectional shape and roughness<br>❑ Presence Or Absence Of Overbank flow, channel network<br>❑ Synchronisation of run-offs from various parts of watershed<br>❑ High tide impeding drainage |

### Anthropological Factors Also Contribute to Urban Flooding

- **Land Use Changes:** Surface sealing and deforestation increase runoff and sedimentation in urban areas. For example, Hyderabad in 1929 had 400 lakes and 48 flood-absorbing tanks which are now reduced to only 169 lakes due to land use changes.
- **Unplanned Urban Settlements:** According to NITI Ayog 65% of urban settlements lack City Master Plan.
- **Occupation of Flood Plains:** Unregulated growth of infrastructure obstructs natural flows.
- **Water Release from Dams:** Sudden release upstream of cities and towns increases flood peaks. Excessive release from the Sardar Sarovar dam caused flooding in the Bharuch district of Gujarat in 2023.
- **Unplanned Tourism Activities:** Unplanned tourism development and waste disposal degrade water bodies, exacerbating flood risks and health hazards, as seen in Ashtamudi Lake, Kollam, Kerala.
- **Urban Heat Island Effect:** Recent studies such as the Metropolitan Meteorological Experiment (METROMEX) conducted in St. Louis, USA, found that urbanisation led to a 5-25 per cent increase in summer precipitation within and 50- 75 km downwind of the city. In **India, urban heat islands over Pune and Chennai** have been reported. There has been an increase in the average annual rainfall of Hyderabad from 806 mm in 1988 to 840 mm in 2002.
- **Illegal Mining Activities:** Illegal mining of river sand and quartzite accelerates soil erosion, diminishes water retention capacity, and amplifies flood risks, as observed in Jaisamand Lake, Jodhpur, and the Cauvery River, Tamil Nadu.

### Case Study-The Bangalore Failure

**Reasons for Bangalore Flood 2022**

- **Loss of interconnectivity among lakes in the region:** In 1800, Bangalore (740 sq km region) had 1,452 water lakes which helped in optimally harvesting rainwater and also mitigated flooding. **Now only 193 lakes are left and most of them have lost connectivity due to blocking of rajakaluves (storm water drains) with solid waste or because of encroachment.**
  - The silt deposited in the lakes also reduces the water-holding capacity of the lakes.
- **Encroachment problem:** There are more than 6,000 illegal layouts across the city. Over 22 layouts have been constructed on lake beds across the city.
  - Encroachment into lakes and watersheds destroyed wetlands, reduced greenery and concretization of lands.

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### Urban Flood Risk in India

- **Increasing Frequency:** There has been an increasing trend of urban flood disasters in India over the past several years whereby major cities in India have been severely affected. The most notable amongst them are Hyderabad in 2000, Ahmedabad in 2001, Delhi in 2002,2003, 2009 and 2019 Chennai in 2004, 2015, 2023, Mumbai in 2005, Surat in 2006, Kolkata in 2007, Jamshedpur in 2008, and Guwahati in 2010.
- **Heavy rainfall and less prevention:** A special feature in India is that we have heavy rainfall during monsoons. There are other weather systems also that bring in a lot of rain. Storm surges can also affect coastal cities/ towns. Sudden release or failure to release water from dams can also have severe impacts. In addition, the urban heat island effect has resulted in an increase in rainfall over urban areas.
- **Climate Change:** Global climate change is resulting in changed weather patterns and increased episodes of high intensity rainfall events occurring in shorter periods of time. Then the threat of sea-level rise is also looming large, threatening all the coastal cities. Cities/ towns located on the coast, on river banks, upstream/ downstream of dams, inland cities and in hilly areas can all be affected.



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- **Administrative Lapse:** Stormwater drainage systems in the past were designed for rainfall intensity of 12–20 mm. These capacities have been getting very easily overwhelmed whenever rainfall of higher intensity has been experienced. Further, the systems very often do not work to the designed capacities because of very poor maintenance.

### Role of Watershed Measures and Groundwater Recharge in Urban Flooding Mitigation

By replenishing groundwater through recharge methods like rainwater harvesting and watershed development, **we essentially reduce surface runoff during heavy rains.** This **lessened runoff translates to decreased pressure on urban drainage systems**, lowering the risk of overflows and subsequent flooding. Additionally, healthy watersheds with good vegetation cover act like sponges, slowing down water flow and promoting natural infiltration, further mitigating flood peaks in cities downstream.

## Steps Taken by the Government

- **Master Plan for Artificial Recharge to Groundwater - 2020:** It has been prepared by the Central Ground Water Board (CGWB) in collaboration with States/UTs envisaging construction of about 1.42 crore rain water harvesting and artificial recharge structures in the country to harness 185 Billion Cubic Meters (BCM) of water.
- **Jal Shakti Abhiyan:** Focuses on rainwater harvesting, groundwater recharge, watershed management, and afforestation.
- **The Amrit Sarovar Mission:** It has been launched with an aim to develop and rejuvenate 75 water bodies in each district of the country as a part of celebration of Azadi ka Amrit Mahotsav for rainwater harvesting/recharge.
- **Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0 Scheme:** Under this scheme provisions have been made for Harvesting the **rainwater** through **storm water drains** into water bodies (which are not receiving **sewage**/effluent)
- **Steps by Central Ground Water Board (CGWB)**
  - CGWB has implemented artificial recharge work in three Aspirational Districts, Osmanabad (Maharashtra), YSR Kadapa (Andhra Pradesh) and Jangaon (Telangana). In these Districts, **176 structures have been constructed to harvest the runoff water in stream to store at suitable locations for augmenting recharge to the ground water.**
  - CGWB has also implemented **Bridge cum Bandhara (BCB)** for ground water recharge in the districts of Wardha and Amravati of Maharashtra State at five locations.
- **MoHUA issued Standard Operating Procedures (SoPs) on Urban Flooding** in 2017 and published a manual on Storm Water Drainage Systems, 2019 to assist the States/Union Territories (UTs), Urban Local Bodies (ULBs) and other stakeholders in planning, designing, operation and maintenance of storm water drainage systems and to assist all States/ UTs to raise the level of preparedness in the event of urban flooding, and for emergency operations, including rescue and restoration of services.
- **National Water Policy (2012):**
  - **Integrated Water Management:** The storage capacities of water bodies, associated wetlands, flood plains, ecological buffers and areas required for specific aesthetic recreational and/or social needs may be managed to the extent possible in an integrated manner to balance the flooding, environment and social issues as per prevalent laws through planned development of urban areas, in particular.
  - **Protecting Water Resources:** Urban settlements, encroachments and any developmental activities in the protected upstream areas of reservoirs/water, key aquifer recharge areas that pose a potential threat of contamination, pollution, reduced recharge and those endanger wild and human life should be strictly regulated.

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## Challenges in Urban Flood Mitigation

- **Inadequate Drainage Systems:** Existing systems are often outdated, undersized, and poorly maintained. Encroachment on natural drainage channels further exacerbates the problem.
- **Urbanisation and Impervious Surfaces:** Rapid urbanisation leads to increased paved areas, reducing water infiltration and causing surface runoff, and overwhelming drainage systems.
- **Solid Waste Management**: Improper waste disposal clogs drains, impeding water flow.
- **Lack of Integrated Planning:** Disjointed urban planning often neglects flood control measures, leading to haphazard development in flood-prone areas.
- **Climate Change:** Increased rainfall intensity and more frequent extreme weather events pose growing threats.
- **Financial Constraints:** Implementing comprehensive flood mitigation projects requires significant investment, often a constraint for resource-strapped urban bodies.
- **Social and Political Issues:** Land acquisition for drainage improvements and relocation of encroachers can be challenging due to complex social and political dynamics.

## Way Forward

- **Investing in improved drainage infrastructure:** Upgrading and expanding drainage systems to handle increased rainfall is crucial.



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- **Restoring and protecting natural waterways:** Encroachment on rivers, streams, and wetlands must be stopped, and these areas should be restored to their natural state.
- **Improving solid waste management:** Efficient waste collection and disposal systems are essential to prevent drains from clogging.
- **Promoting sustainable urban planning**: Urban planning should prioritise green spaces, permeable surfaces, and rainwater harvesting to reduce runoff and increase water infiltration.
- **Raising awareness and community engagement**: Educating communities about flood risks and preparedness measures can help to reduce the impact of floods.

### NDMA Guidelines on Urban Flood (2010)

- **Early Warning System and Communication**
  - Integration of national hydro-meteorological network and Doppler weather radar with urban planning.
  - Automated rain gauges for real-time rainfall communication.
  - Flood forecast characterization and implementation of associated flood management plans.
- **Design and Management of Urban Drainage**
  - Inventory maintenance of the water supply system, especially minor drainage systems.
  - Watershed delineation for drainage system design.
  - Accurate contours for determining watershed/ catchment boundaries.
  - Solid waste removal to prevent blockage and reduce flow capacity.
  - Proper drain inlet connectivity to prevent water logging on roads.
- **Vulnerability Analysis and Risk Assessment**
  - Identification of at-risk areas and classification of structures based on function.
  - Estimation of risk for each structure and function using Hazard Risk Zoning.
- **Urban Flooding Cells**
  - Creation of a separate Urban Flooding Cell (UFC) within the Ministry of Urban Development (MoUD) to coordinate national-level urban flood management activities.
  - Local Urban Bodies (ULBs) are responsible for managing urban flooding at the local level.
- **Response**
  - Establishment of Emergency Operation Centres, Incident Response systems, flood shelters, and search and rescue operations.
  - Emergency logistics as a key component of flood response mechanisms.
- **Sanitation**
  - Implementation of adequate sanitation and disinfection measures to prevent the spread of diseases like malaria, dengue, and cholera.
- **Capacity Development, Awareness Generation, and Documentation**
  - Participatory urban flood planning and management involving local government and the community.
  - Capacity development initiatives, awareness campaigns, and documentation for effective flood management.

### Best Practices in Urban Flood Mitigation

- **Copenhagen, Denmark**: The city has incorporated numerous green spaces and rain gardens into its urban design, significantly reducing stormwater runoff and improving water quality.
- **Sponge City initiative in China:** This ambitious program aims to turn Chinese cities into "sponges" that can absorb and reuse rainwater, promoting water conservation and flood mitigation.
- **Netherlands:** Instead of merely trying to barricade water out, the Dutch approach is to let it flow where it won't do any damage. The country is dotted with ponds, lakes, seaside parking garages and city plazas that double up as water storage ponds during flooding events.

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**IGNITE YOUR MIND**

The Mauryan Empire thrived by anticipating and mitigating monsoons. Can we analyze their water management systems and weather forecasting methods, combining them with advanced technology, to create proactive flood preparedness strategies for modern India?

## Glacial Lake Outburst Flood (GLOF)

GLOF, or Glacial Lake Outburst Flood, refers to the sudden release of water from glacial lakes, primarily confined by loose moraine, creating a potential flood hazard. The Indian Himalayan Region (IHR), home to around 9,575 glaciers that serve as the perennial sources for the Indus, Ganga, and Brahmaputra rivers, faces the recognition of GLOFs as a climatological disaster in India's 2019 National Disaster Management Plan (NDMP).

### Glacial Lakes and Its Types

A glacial lake is a body of water that originates from a glacier. These lakes are commonly found along the peripheries of glaciers and ice sheets, transitioning from ice-contact to ice-distal lakes as glaciers recede. Glacial lakes develop primarily in two regions i.e. behind moraine dams and ice dams. It has been divided into the following types:



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1. **Moraine Dammed Lakes:** Formed when a receding glacier leaves a depression that fills with water, creating a lake, commonly known as a moraine. These lakes are contained by unstable mounds of debris and submerged ice. Moraines are typically built during periods such as the Little Ice Age.
2. **Ice-Dammed Lakes:** Created when advancing or thicker glaciers block the drainage of meltwater, resulting in lakes obstructed by ice. Anywhere a glacier impedes the flow of meltwater, ice-dammed lakes are formed.

### Causes of Glacial Lake Outburst Flood

- **Dam Failure:** The most common cause of GLOFs is the failure of the **natural dam** that holds the glacial lake in place. This dam can be **made of ice, rock debris (moraine), or a combination of both.** The dam can fail due to a variety of reasons, including Erosion, Melting and external factors such as earthquakes, avalanches, or volcanic eruptions.
- **Rapid Water Input:** In some cases, GLOFs can be triggered by a sudden influx of water into the glacial lake. This can happen due to:
  - **Heavy rainfall or snowmelt:** If a large amount of rain or snow falls in a short period of time, it can quickly fill the lake and cause it to overflow.
  - **Subglacial meltwater:** If meltwater from the glacier builds up under the ice, it can create a cavity that can suddenly collapse, releasing a large volume of water into the lake.

**Datawise**

- Approximately 10% of the Himalayas are covered with glaciers and an additional 30 to 40% support snow cover.
- The Indian Himalayan Region (IHR) comprises about 9,575 glaciers spread across 6 states and union territories. The Himalayan glaciers cover a total area of 71,182.08 km², with 32,392 glaciers.
- The Indus basin has 16,049 glaciers, the Ganga basin has 6,237 glaciers, and the Brahmaputra basin has 10,106 glaciers.
- Researchers estimate that about 17% of the Himalayas and 37% of the Karakoram are covered by glacier ice.

### Glacial Lake Outburst Flood (GLOF) Risk in India

- **Climate Impact in the Himalayas:** Visible climate impact in the Himalayas, with 25 glacial lakes and water bodies witnessing an increase in water spread area since 2009, indicating a heightened risk of GLOFs in the region.
- **Most Risk Prone States:** In the Himalayan region, Sikkim's State Disaster Management Authority identifies over 300 glacial lakes, with 10 classified as vulnerable, while NRSC's assessment reveals 733; in Uttarakhand, 13 out of 486 glacial lakes are found vulnerable by the Geological Survey of India; a 2021 study highlights Jammu and Kashmir having the highest number of vulnerable glacial lakes, emphasising the widespread threat of Glacial Lake Outburst Floods (GLOFs) in the Himalayas.

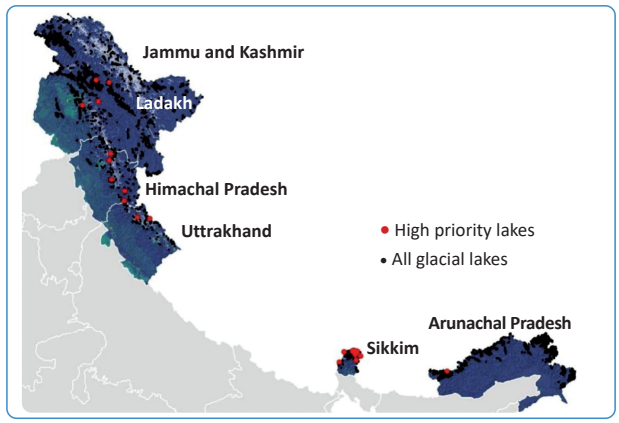


**Fig. 3.5:** High Priority Lakes in Himalayas

- **High Population Exposure:** According to a new study led by scientists at Newcastle University, 3 million people in India face a significant risk of flooding caused by glacial lakes, representing the highest exposed population globally.
- **Loss of lives:** The ICIMOD reports that the GLOF outburst in South Lhonak Lake, Sikkim, in October 2023 caused 102 deaths, while a regional effort documents over 7,000 lives lost to GLOF outbursts since 1833 across the Hindu Kush Himalayan region.

### Impact of GLOF

- **Loss of life:** The rapid and powerful surge of water from a GLOF can sweep away people, homes, and infrastructure. The 2013 Uttarakhand floods, triggered by the Chorabari Glacier Lake outburst, claimed over 5,000 lives, making it one of the deadliest natural disasters in India's history.
- **Infrastructure damage:** GLOFs can cause widespread damage to roads, bridges, power lines, and other critical infrastructure. This can disrupt essential services, hamper rescue and relief efforts, and hinder economic activity in the affected areas.
- **Environmental damage:** The force of a GLOF can erode riverbeds, alter river courses, and disrupt ecosystems. This can have long-term consequences for biodiversity and the delicate balance of the Himalayan environment.

### Steps Taken by the Government

- **Meteorological observation stations:** Central Water Commission (CWC) has 46 existing meteorological observation stations in the Himalayan region, 1,000 meters above mean sea level out of which 35 stations are telemetry-based stations. As many as **16 new telemetry-based meteorological observation stations have been proposed** in the Himalayan region, which are under various stages of implementation.
- **Defense Geo-informatics Research Establishment (DGRE):** DGRE has been working to enhance the

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number of Automatic Weather Stations for forecasting avalanches and landslides in a phased manner to increase the coverage area in the states of Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh and in the union territories of Jammu & Kashmir, and Ladakh. It has already established three Mountain Meteorological Centers in Ladakh, Jammu and Kashmir and Uttarakhand for avalanche study.

- **Joint Initiative of DGRE and Swiss Federal Institute for Snow and Avalanche Research (SFISAR):** DGRE has joined hands with the Swiss Federal Institute for Snow and Avalanche Research (SFISAR) to develop a model for forecasting.

- **Automatic Weather Stations:** A network of 35 Automatic Weather Stations is to be built soon in the border state of Sikkim to generate avalanche forecast data for the armed forces.
- **Monitoring by Government Agencies:** There are other government agencies to monitor, predict and undertake research on GLOF, landslide lake outburst flood (LLOF), cloudburst flood, and so on, such as the Geological Survey of India, Department of Science and Technology, Defense Research and Development Organization and the ministries of Environment, Forests and Climate Change and Earth Sciences.

## Challenges in Mitigation of GLOF

- **Diverse Hazards:** The Himalayan Region faces various hydro-meteorological, tectonic, climate, and human-induced hazards, requiring comprehensive mitigation strategies.
- **Monitoring Complexity:** Monitoring is challenging due to the multitude of glaciers, varying glacial recessions, and the dynamic nature of risk estimation.
- **Transboundary Complexity:** The transboundary nature of glacial lakes demands international cooperation for effective risk management.
- **State and UT Variability:** Managing glacial lakes in India involves addressing regional variability across states and Union Territories, requiring tailored strategies.

## Way Forward

**Parliamentary Standing Committee recommendation on GLOF Mitigation**

- **Modernising Monitoring: It is recommended to** set up and **widen the network of high-altitude meteorological and discharge stations equipped with modern technology including Synthetic Aperture Radar imagery** to automatically detect changes in water bodies and lake formations in the Indian Himalayan region.
- **Capacity Building:** It has told the Jal Shakti ministry to **work in "close collaboration" with other agencies involved in glacial management and analysing the mountain hazards** by sharing data with them which the ministry has agreed.

## NDMA Guidelines on GLOF (2020)

- **Hazard and Risk Mapping**
  - Robust hazard and risk assessment is crucial for Disaster Risk Management in changing mountain regions.
  - National and location-specific evaluations are essential for effective risk management.
  - Regular satellite monitoring is key for GLOF risk assessment, requiring standardised approaches.
  - Regional cooperation is needed for high-priority lakes in the Indian Himalayan Region (IHR).
  - Field studies and hazard modelling inform detailed assessments of GLOF scenarios.
- **Monitoring, Risk Reduction And Mitigation Measures**
  - Structural and organisational measures, including spatial planning with hazard maps.
  - Local community involvement, considering risk perceptions, enhances effectiveness.
- **Awareness and Preparedness**
  - Short-term strategies include local initiatives with signage, toll-free numbers, web platforms, and apps.
  - Medium-term involves mainstreaming GLOF risks through media and local capacity development.
  - Long-term plans include national campaigns, a GLOF data centre, and school involvement.
- **Capacity Development**
  - Incorporating GLOF education into the curriculum, organising professional courses and workshops, and establishing a database of past incidents is essential for capacity development.
  - Continuous learning and adaptation to evolving tools and techniques are crucial for the effective management of the increasing GLOF hazards due to climate change.
- **Disaster Response**
  - Local community training through an Incident Response System (IRS) for effective disaster response.
  - The SOP outlines three stages for agencies to monitor weather, plan evacuations, and conduct post-event assessments.
- **Research and Development**
  - Use of local knowledge for community-based risk management.
  - Future-oriented risk management must address human infrastructure expansion into high mountain areas.
- **Regulation and Enforcement**
  - Form a committee to draft regulations addressing increased GLOF/LLOF risks within a year.

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- Establish a unified legislation controlling development and building activities.
- Mandate buildings, especially critical infrastructure, to adhere to the latest safety codes.
- Raise awareness at all levels, starting with decision-makers, on safety against natural hazards and the legal framework.

❑ **Action Plan and Implementation**

- Designate the Ministry of Jal Shakti and CWC as the Nodal Ministry and Agency for glacial studies, including GLOF.
- Allocate specific funds in annual plans for disaster awareness, preparedness, and mitigation.
- Establish a fully autonomous Centre for Glacial Research, Studies, and Management under MoJS for glacial research, studies, and management.
- Form a high-level scientific Technical Advisory Committee for guidance.

## Landslides

Landslides are gravitational movements of rocks, earth masses, or debris down mountain slopes, often triggered by factors such as groundwater pressure, earthquakes, erosion, and volcanic eruptions, leading to the instability of hilly slopes.

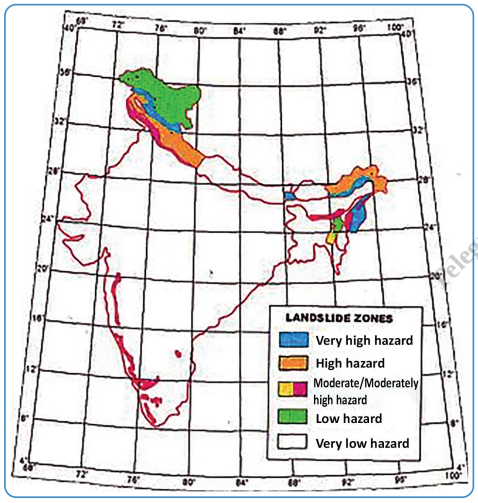


**Fig. 3.6:** Landslide Prone Areas In India

### Causes of Landslides

❑ **Heavy Rainfall:** Intense or prolonged rainfall saturates the ground, reducing its stability and making it more prone to sliding. Think of it like adding too much water to a sponge – eventually, it overflows.

❑ **Earthquakes:** The shaking and ground displacement caused by earthquakes can destabilise slopes and trigger landslides, especially in areas with already loose or fractured soil.

❑ **Erosion:** Natural processes like wind and water can erode soil and rock, weakening slopes and increasing the risk of landslides.

❑ **Changes in groundwater levels:** Fluctuations in groundwater levels, such as those caused by heavy rain or snowmelt, can alter the pressure within soil and rock, leading to instability and landslides.

❑ **Volcanic activity:** Volcanic eruptions can trigger landslides through seismic activity,mudflows, and lahars (hot, fast-moving mudflows).

❑ **Deforestation:** Trees and their roots help bind soil together and anchor it to slopes. Removing trees weakens the soil and makes it more susceptible to landslides, especially during heavy rain.

❑ **Mining and quarrying:** Removing large amounts of soil and rock for mining or quarrying can create unstable slopes and trigger landslides.

### Risk of Landslides in India

❑ **Geographical Distribution of Landslides:** According to the Geological Survey Of India (GSI), about 0.42 million square kilometres, or 12.6% of the country's land area, is susceptible to landslide hazards. Landslides predominantly occur in India's hilly regions, including the Himalayas, North-East India, Nilgiris, Eastern Ghats, and Western Ghats.

❑ **Most Prone Area:** Approximately 30% of the world's landslides occur in the Himalayan ranges, characterised by a unique structure of seven curvilinear parallel folds spanning 3,400 kilometres.

❑ **Trigger Points:** Unprecedented rainfall saturated soil, increasing landslide risks. In 1978, extensive rains triggered around one hundred landslides in the Nilgiris, causing severe damage to communication lines, tea gardens, and cultivated crops.

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**Landslide Zones in India**

| Moderate-Low Vulnerable Landslide Zones | High Vulnerable Zones | Very High Vulnerable Zones |
|---|---|---|
| ❑ Trans Himalayan region<br>❑ Spiti of Himachal Pradesh<br>❑ Aravalli mountains<br>❑ Deccan Plateau<br>❑ Chhattisgarh<br>❑ Jharkhand<br>❑ Odisha | ❑ Northeastern region<br>❑ the Eastern Ghats<br>❑ Konkan Hills<br>❑ Nilgiris | ❑ Andaman and Nicobar Island<br>❑ Western Ghats<br>❑ Darjeeling<br>❑ Sikkim<br>❑ Uttarakhand |



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## Impacts of Landslides in India

- **Traffic Disruption:** Mud, debris, and rocks sliding from slopes during landslides can restrict human movement, creating barriers on highways and railway lines. For instance, in 2021, a landslide blocked National Highway-5 in the Badhal district.
- **Loss of Human Lives:** Landslides lead to a severe loss of human lives. An example is the landslide in the Kinnaur district of Himachal Pradesh in August 2021, which resulted in the tragic death of approximately 28 people.
- **Infrastructure Damage:** Landslides cause significant damage to houses, roads, and buildings, imposing a financial burden for the reconstruction of infrastructure and the rehabilitation of affected communities.
- **Water Supply Disruption:** Debris sliding down from slopes during landslides can fully or partially block river channels, making it challenging for locals to access water supply.
- **Increased Flood Risk:** Landslides contribute to an increased risk of floods by adding debris to river sediment. This alteration in river courses can lead to irregularities, causing frequent floods.
- **Environmental Crisis:** Landslides are considered a chief factor behind environmental crises, as seen in the case of the Joshimath sinking crisis in January 2023, leading to mass evacuations and posing a threat to the environment.

### Case Study-Himachal Pradesh

**Increasing Incidence:** Himachal Pradesh has witnessed a six-time increase in major landslides in the past two years with **117 occurring in 2022 as compared to 16 in 2020.**

### Reason for the Rise

**Cutting Hill slopes:** Extensive cutting of hill slopes for construction and widening of roads, blasting for tunnels, hydro projects and mining are cited as reasons behind the increase in landslides.

**Climate Change:** Though the time span of rains has been reduced, their intensity has increased. High temperatures coupled with heavy rains lead to landslides due to loosening of the strata in places which have undergone cutting downstream on the foothills.

## Government Measures

- **National Landslide Risk Management Strategy 2019:** It highlights the **six pillars of the NLRMS: Hazard mapping, early warning systems, awareness and capacity building, mitigation and stabilisation, regulations and policies, and research and development.**
  - **Hazard Mapping and Monitoring:** Creating detailed landslide hazard maps using advanced technologies like Light Detection and Ranging (LiDAR) and remote sensing.
  - **Early Warning Systems:** Utilising various communication channels like sirens, mobile apps, and SMS to ensure effective dissemination of warnings.
  - **Awareness and Capacity Building:** Educating communities living in landslide-prone areas about the risks, preparedness measures, and evacuation procedures. It also advised training government officials, disaster response teams, and volunteers in landslide risk management and mitigation techniques.
  - **Mitigation and Stabilization:** This will be done through measures such as afforestation, bioengineering slopes, and drainage improvements to reduce landslide susceptibility.
  - **Regulations and Policies:** Strengthening building codes and land-use regulations to prevent construction in high-risk zones and ensure safe construction practices. It further emphasised enforcing zoning regulations and environmental laws to prevent deforestation and unsustainable land-use practices.
  - **Research and Development:** Promoting research and development activities in landslide forecasting, monitoring, and mitigation technologies. Collaborating with academic institutions and international experts to share knowledge and develop innovative solutions.

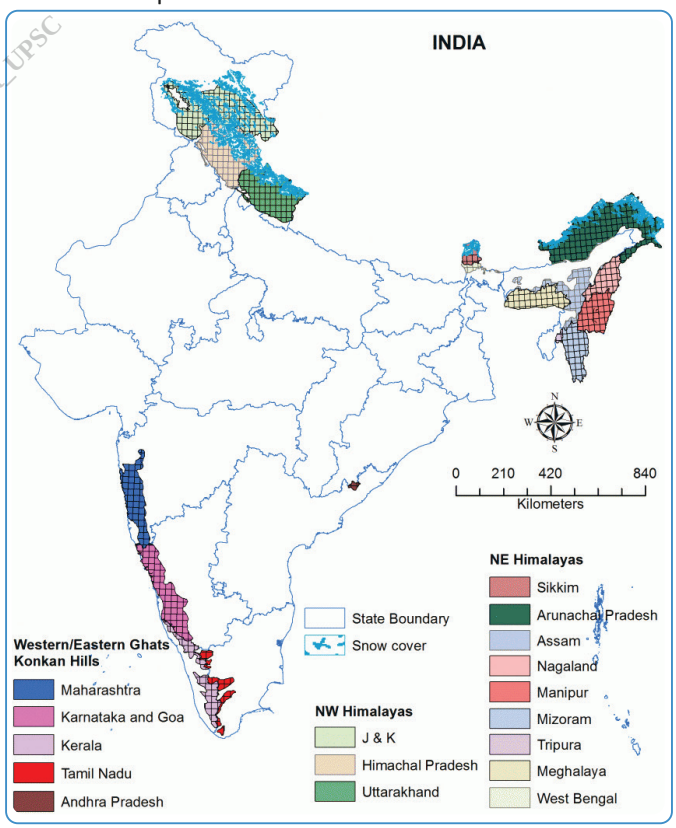


**Fig. 3.7:** Landslide Hazard Zonation Map

- **Landslide Risk Mitigation Scheme (LRMS):** The under preparation scheme envisages financial support for site specific Landslide Mitigation Projects recommended by landslide prone States, covering "disaster prevention



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strategy, disaster mitigation and R&D in monitoring of critical Landslides" thereby leading to the development of an Early Warning System and Capacity Building initiatives.

- **Landslide Hazard Zonation Map:** The **Indian Space Research Organisation (ISRO)** has carried out landslide susceptibility zonation mapping in the Northwest and Northeast Himalayas.
  - ISRO has also constructed a network of 30 Global Navigation Satellite System-based Continuously Operating Reference Stations across the Himalayan belt to monitor the process of crustal deformation.
- The **Geological Survey of India (GSI)** has conducted research and development studies with field validation across the country's landslide-prone areas. GSI has constructed a **Seismo-Geodetic Data Receiving and Processing Centre,** which receives and analyses real-time Seismo-Geodetic Data from Remote Broadband Seismic Observatories placed around the country.
  - GSI has already developed and implemented a macro-scale **National Landslide Susceptibility Mapping** (NLSM) Programme.

## Way Forward

The main mitigation measures adopted for landslide prone areas are **proper land use; drainage correction, reforestation of the areas occupied by degraded vegetation; and above all, creation of awareness among local people.**

- **Reduce damage:** Locate development activities on **stable ground and utilise the landslide susceptible areas as open space as parks, grazing or afforestation.**
- The afforestation programme should be properly planned so that there is very little slope modification in this process.
- **Improve slope stability:** Water infiltrates the overburden (layers above the bedrock), increasing pore pressure and reducing the soil's internal friction. This weakens the slope, particularly on steep terrain, potentially triggering mass movements like landslides. The **best natural method is reducing infiltration and allowing excess water to move down without hindrance.** As a result, drainage correction is an important mitigation measure that involves maintenance of natural drainage channels in vulnerable slopes.
- States like Uttarakhand and Himachal should take great caution in pursuing disruptive projects. There should be **proper implementation of Environmental impact assessment** norms before initiating mining or dam construction.
- There should be the **adoption of landslide micro zoning procedures** for mountainous and other highly vulnerable regions.
- There should be **involvement of locally available trained manpower** to intensify the hazard reduction and public awareness programs.

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## Landslide Hazard Mitigation Guidelines by NDMA

- **Identification of Hazard Zones and Hazard Mapping:** Specific hazard zones must be identified, and measures for stabilising and managing particular slides should be implemented. Monitoring systems and early warning systems should be established at selected sites. Conducting hazard mapping to pinpoint areas prone to landslides is essential for targeted mitigation efforts.
- **Area-Specific Measures:** It is recommended to adopt area-specific measures to effectively deal with the unique characteristics of landslides in different regions.
- **Restrictions on Development Activities:** Enforcing restrictions on construction and other developmental activities, such as roads and dams, with limitations on agriculture in valleys and areas with moderate slopes. Controlling the development of large settlements in high-vulnerability zones is crucial.
- **Afforestation and Bund Construction:** Encouraging large-scale afforestation programs and constructing bunds to reduce the flow of water, thereby mitigating landslide risks.
- **Promotion of Terrace Farming:** Promoting terrace farming, particularly in the northeastern hill states, as an alternative to Jhumming or shifting cultivation practices.
- **Construction of Retaining Walls:** Building retaining walls on mountain slopes to prevent land slippage and treating vulnerable slopes and existing hazardous landslide areas accordingly.
- **Development of Codes:** Developing codes for excavation, construction, and grading to ensure safe practices in landslide-prone areas.
- **Landslide Insurance and Compensation:** Establishing arrangements for landslide insurance and compensation for losses to facilitate recovery and encourage risk mitigation practices.

### The Great Himalayan Blunder: The Shimla Story

Nestled in the Himalayas, Shimla, once a quaint hill station, now faces a precarious future due to urbanisation, environmental degradation, and vulnerable construction practices.

#### Issues

- **Population Explosion:** Built for 25,000, Shimla now houses nearly 2,50,000, exceeding recommended density limits by tenfold. This has strained the fragile ecosystem and increased potential landslide triggers.
- **Environmental Imbalance:** Deforestation, road cutting, and altered agricultural practices have disrupted the natural equilibrium of the hills, weakening slopes and increasing waterlogging.
- **Structural Vulnerability:** With 90% of central Shimla built on a 60-degree slope, the densely packed, multi-story buildings pose a grave danger in an earthquake. Construction shortcuts, like shallow foundations resting on loose soil, further exacerbate the risk of collapse.



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### Potential Consequences

- A landslide or earthquake could trigger a domino effect, with collapsing buildings cascading down the steep slopes, causing catastrophic loss of life and property.
  - For example, In the event of an earth tremor, the devastation could be enormous, with buildings on slopes steeper than 45 degrees collapsing in a chain.

### Possible Solutions

- No construction should be ordinarily undertaken in areas having slopes above 30 degrees or areas which fall in landslide hazard zones or areas falling on the spring lines and first order streams.
- The NLRMS 2019 report also emphasised the **necessity of load bearing tests, hazard zonation and slope and land-use maps to guide urban planners in clearing constructions.**

## Cloudburst

A cloudburst is a catastrophic weather phenomenon characterised by intense and rapid rainfall occurring over a localised area. The defining criteria for a cloudburst include rainfall of 10 cm or more per hour over an approximate area of 20-30 square kilometres. This extreme precipitation event can **lead to flash floods, landslides, and significant damage to infrastructure and communities** within the affected region.

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### Causes of Cloudburst

- **Orographic Uplift:** Cloudbursts are more frequent in mountainous regions due to the phenomenon of orographic uplift. As **moist air masses rise over mountains, they cool down and condense, forming clouds**. The rising air current also strengthens the updrafts within the clouds, causing water droplets to collide and grow in size.
- **Atmospheric Instability:** Cloudbursts often occur when conditions within the atmosphere are highly unstable. This means that warm, moist air rises rapidly and encounters colder air above, intensifying the condensation process and leading to a sudden release of precipitation. Factors like high humidity, low pressure, and strong updrafts contribute to this instability.
- **Convergence of Air Masses:** When air masses with different temperatures and moisture content converge, the resulting pressure difference can trigger the rapid ascent of air, creating conditions conducive to cloudbursts. This is particularly relevant in monsoon seasons, where warm, moist air from the ocean meets cooler air masses over land.
- **Local Topography:** The specific topography of an area can also play a role in triggering cloudbursts. Steep slopes and narrow valleys can channel and concentrate the rainwater, leading to localised flooding even with relatively small amounts of rainfall.

### Cloudburst Risks in India

- **Greater Probability in Mountainous Zones:** In India, cloudbursts mostly occur during the monsoon season in the mountainous regions at elevations between 1,000-2,500 metres above sea level, when moisture-carrying air moves up a hilly terrain, then forming a vertical column of 'cumulonimbus' clouds.
  - These clouds are unstable in nature thus, causing an intense rainstorm over a small area on getting locked between the ridges and valleys after becoming very heavy.
- **Geographically prone areas:** Cloudbursts in India are prevalent in orographically dominant regions such as the Himalayan region, north-eastern states, and the Western Ghats.
- **Extreme Precipitation and Global Warming:** Events of extreme precipitation, including cloudbursts, have shown an increasing trend in the last few decades, attributed in part to global warming. The changing climate patterns contribute to more intense and frequent rainfall events.

### Impact of Cloudbursts

- **Flash Floods and Landslides:** Cloudbursts frequently trigger flash floods and landslides, posing immediate and severe threats to life and property.
- **Danger in Compact Spaces:** The suddenness of cloudbursts can be especially dangerous in compact and enclosed spaces on slopes, making timely rescue and relief challenging.
- **Infrastructure Damage:** The force of flash floods and landslides can result in extensive damage to infrastructure, including roads, bridges, buildings, and utilities. The destruction hampers normal life and requires substantial resources for reconstruction.
- **Disruption of Communication:** The impact of cloudbursts often includes the disruption of communication networks, making it challenging for authorities to coordinate rescue and relief efforts. This exacerbates the challenges of responding to the disaster.
- **Environmental Consequences:** Cloudbursts contribute to environmental degradation by causing soil erosion, altering landscapes, and depositing debris in water bodies. This can lead to long-term ecological imbalances in affected areas.

### Steps Taken by the Government

- **Expansion of doppler radar footprints:** To prevent damage to life and property caused by extreme rainfall events, the India Meteorological Department (IMD) has planned a massive expansion of its doppler radar footprints to improve forecast of the cloudbursts.



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- **Automatic weather stations:** IMD has come up with a plan to set up automatic weather stations in every block and automatic rain gauge in each panchayat of the country.
- **Augmented weather observation systems:** States like Odisha are augmenting their weather observation systems. The plan is to have an integrated observation system which IMD will monitor and provide the forecasts.

## Challenges in Cloudburst Mitigation

- **Prediction:** Anticipating cloudbursts poses challenges due to their rapid onset over a short period, requiring an expensive and extensive radar network. While identifying areas prone to heavy rainfall is feasible, precise prediction of cloudbursts remains difficult, emphasising the need for enhanced meteorological understanding and community preparedness to mitigate potential damage. Efforts to proactively address the dynamic nature of cloudbursts through advanced technologies and strategic planning are crucial.
- **Expensive Technology:** Cloudburst is one such phenomenon which is unpredictable. Even with the development in technology, **'DOPPLER RADARS'** are being used to help in predicting the possibility of the occurrence of cloudbursts, but such radars are extremely expensive and installation is not always feasible.
  - **Himalayan region has only seven doppler radars** — two in Jammu and Kashmir (Sonmarg and Srinagar), one each in Uttarakhand (Kufri), Mukteshwar (Uttarakhand), Mohanbari (Assam), Meghalaya (Sohri) and Tripura (Agartala). There are **only 39 Doppler Weather Radars (DWRs) radars present in the country as of December 2023**. The number has increased by just 6 in the last 5 years.
  - Satellites fail to detect the cloudburst systems as the resolution of the precipitation radars is much smaller than the area of individual cloudburst events.
- **Underreporting:** Due to their highly localised and short occurrence, most of these events go unreported due to the lack of monitoring mechanisms. Thus, cloudburst forecasts still remain elusive
- **Climate Change boost frequency:** Even though the meteorological data states that the amount of rainfall in India did not change much, **there has been a significant increase in the proportion of rainfall in a short span of time over a particular area.** As emissions continue to increase and global commitment to reduce emissions is gradually proving to be insufficient, these temperatures are set to hit 1.5°C during 2020-2040 and 2°C during 2040-2060. This will double the occurrence of cloudbursts.

## Way Forward

- **Advanced Forecasting Models:** Invest in developing and adopting high-resolution weather forecasting models to predict cloudbursts with greater accuracy and lead time. **Japan's** dense network of radars and advanced forecasting models provide early warnings with lead times of up to several hours, allowing for timely evacuation and mitigation efforts.
- **Natural Drainage Restoration:** Restore and protect natural drainage channels like streams and wetlands to improve water infiltration and reduce surface runoff. **Austria** has implemented comprehensive flood protection measures, including retention basins, diversion channels, and dikes, significantly reducing flood damage in high-risk areas.
- **Floodplain Zoning:** Designating floodplain zones to limit construction, thus minimising damage to human settlements and infrastructure.
- **Strengthening of Infrastructure:** Reinforcing critical infrastructure such as roads, bridges, and water supply systems to enhance resilience against natural disasters.
- **Development and Regular Updating of Emergency Response Plans**: Formulating and regularly revising emergency response plans to ensure prompt and effective disaster response.
- **Regular Training and Drills:** Conducting frequent training sessions and drills for disaster response teams, community volunteers, and the general public to enhance preparedness and response capabilities.

## Cloudburst Mitigation Guidelines by NDMA

- **Early Warning Systems:** This system should include state-of-the-art weather monitoring technologies, such as Doppler radars and satellite imagery, to detect and predict cloudburst events accurately. The NDMA guidelines emphasise the need for timely dissemination of warnings to vulnerable communities through various communication channels, including mobile alerts, sirens, and community-based mechanisms.
- **Infrastructure Development:** The NDMA guidelines advocate the construction of well-designed drainage systems, retaining walls, and embankments in high-risk areas prone to cloudbursts. These structures should be designed to effectively channelize the excess water and prevent flash floods, thereby protecting human settlements and critical infrastructure such as roads, bridges, and buildings.
- **Land-Use Planning:** The NDMA guidelines stress the need for identifying and mapping vulnerable areas prone to cloudbursts and restricting construction in these regions. Strict adherence to zoning regulations and building codes can help reduce the exposure of human settlements to the risks associated with cloudbursts.
- **Reforestation and Soil Conservation:** The NDMA guidelines highlight the importance of reforestation initiatives to enhance the natural water-holding capacity of the soil and reduce soil erosion. Planting indigenous tree species and implementing soil conservation



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measures such as contour ploughing and terracing can effectively stabilise slopes, minimise landslides, and improve water absorption.

- **Capacity Building and Training:** The guidelines emphasise the need to train and equip local communities, disaster response teams, and relevant stakeholders with the necessary skills and knowledge to handle cloudburst situations. Training should include aspects such as early warning system operation, search and rescue techniques, first aid, and community-based disaster management.
- **Public Awareness and Education:** These initiatives should focus on promoting safety practices, such as the creation of emergency kits, evacuation plans, and the establishment of community-based early warning systems.

## Cyclone

Cyclones, atmospheric phenomena characterised by rapid air circulation around a low-pressure centre, lead to violent storms and adverse weather conditions. India's extensive coastline of approximately 7,500 km, including the mainland, **Lakshadweep, and the Andaman and Nicobar Islands, experiences nearly 10% of the world's tropical cyclones.** The Bay of Bengal is a primary genesis area for cyclones, and the east coast of India is frequently impacted. On average, five to six tropical cyclones form each year, with two or three potentially reaching severe intensity.

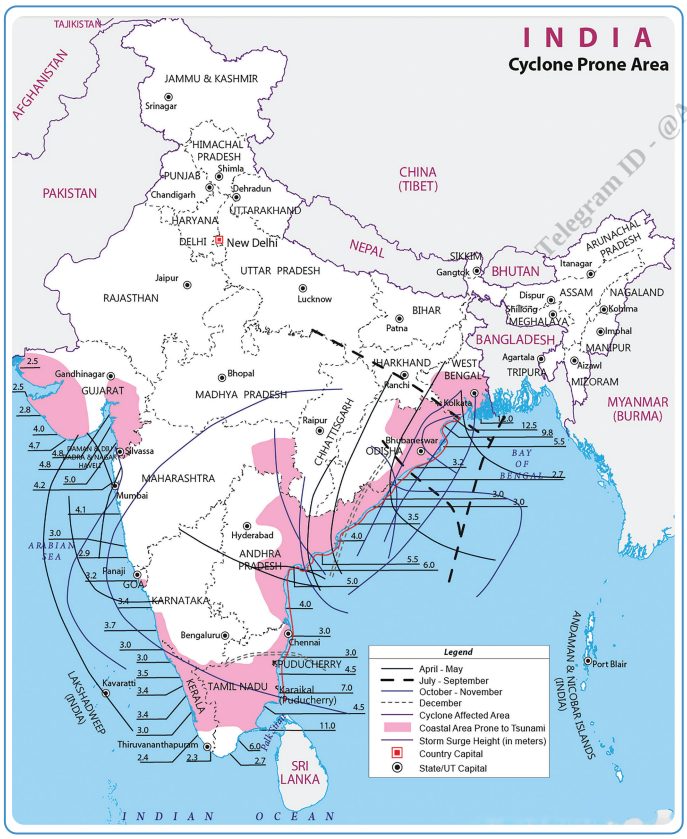


**Fig. 3.8:** Cyclone Prone Areas

### Causes of Cyclone

- **Tropical Cyclone:** These originate and intensify over warm tropical oceans. The conditions favourable for the formation and intensification of tropical storms are
  - Large sea surface with temperature higher than 27° C
  - Presence of the Coriolis force
  - Small variations in the vertical wind speed
  - A pre-existing weak- low-pressure area or low-level-cyclonic circulation;
  - Upper divergence above the sea level system.
  - **Landfall:** The energy that intensifies the storm, comes from the **condensation process in the towering cumulonimbus clouds, surrounding the centre of the storm.** With a continuous supply of moisture from the sea, the storm is further strengthened. On reaching the land the moisture supply is cut off and the storm dissipates. The place where a tropical cyclone crosses the coast is called the landfall of the cyclone.
- **Extra Tropical Cyclones:** The systems developing in the mid and high latitudes, beyond the tropics are called the middle latitude or extra tropical cyclones. The **passage of the front causes abrupt changes in the weather conditions over the area in the middle and high latitudes.**

### Risk of Cyclone in India

- **India's Extensive Coastline:** With a coastline of around 7500 km on the east and west, India is exposed to the hazards of tropical cyclones, storm surges, and heavy rainfall.
  - According to the National Cyclone Risk Mitigation Project (NCRMP) data, around **58 percent of the cyclones formed in the Bay of Bengal make landfall on the eastern coast and 25 per cent in the case of the Arabian Sea.**
- **Major Risk prone regions:** According to the 2021 study by the National Institute of Disaster Management (NIDM), nearly **320 million people in India are vulnerable to the impact of cyclones.** The primary states and union territories prone to the cyclones include Andhra Pradesh, Odisha, Tamil Nadu and West Bengal on the east coast, while Kerala, Karnataka, Maharashtra, Goa and Gujarat are vulnerable on the west coast, along with some Union territories.
- **Population Density:** Most coastal cities in these regions have high population densities, amplifying the potential impact of cyclonic events.

### Impact of Cyclone

- **Economic:** Cyclone affects a local economy, which further affects the national economy – **disruptions to infrastructure, road networks, communication systems, and public properties.** Fisheries are also severely affected as the fish ponds are filled with silt and saline water, and their recovery takes time. People primarily dependent on agriculture, fishing, and aquaculture including crab, prawn, shrimp seeds collection and honey collection for food and livelihood get severely hampered.

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- **Loss of lives:** According to a report by scientists of Earth Sciences Ministry **as many as 117 cyclones hit India in 50 years from 1970-2019 claiming over 40,000** lives.
- **Environmental**: **Sundarbans**, Known as the cyclone capital of India, has battered several cyclones, including **Aila, Amphan, Fani, Yaas, etc. in the span of 15 years.** This has led to an increase in the **salinity of water** in most of the rivers and ponds in almost all areas of the Sundarbans. These ponds filled with **saline water have become the primary source of water for the people living in the area in the absence of fresh water.** This further leads to all kinds of infections and other challenges to human health. Due to the increase in saline water, the mangroves which primarily grow in the freshwater are depleting, further affecting the birth of the species to live around and affecting livelihood.
- **Health**: Heavy rainfall also leads to drainage damage, which hampers the water supply and increases water sanitation problems. **Drainage damage leads to an increase in the number of water-borne and vector diseases, such as Malaria, Dengue, Filaria and Kala-azar, among others,** and the people who have been displaced and moved are unfortunately vulnerable to these diseases.

**Major Cyclones hitting Indian Coast**

| Cyclone | Peak Wind Speed | Human Loss Lives | Loss of Property (Millions Rupees) | Month & Year |
|---|---|---|---|---|
| Chirala | 260 | 8574 | 3500 | November 1977 |
| Machilipatnam | 210 | 700 | 1700 | May 1979 |
| Sriharikota | 210 | 604 | 4000 | November 1984 |
| Machilipatnam | 235 | 967 | 22480 | May 1990 |
| Paradip | 260 | 9887 | – | October 1999 |

## Government Initiatives for Cyclone Preparedness

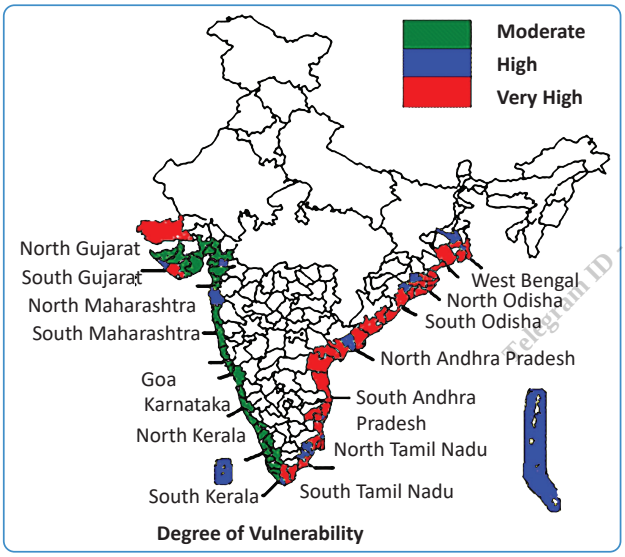


**Fig. 3.9:** Cyclone Hazard Zonation Map

- **Cyclone Hazard Zonation Map:** Based on wind speed and storm surge potential, this map identifies places at risk of cyclones. It divides the country into cyclone hazard zones.
  - The **national cyclone risk mitigation project** intends to improve cyclone forecasting, tracking, and warning technologies, increase capacity in multi-hazard risk management, and create key infrastructure such as multi-purpose cyclone shelters and embankments.
- **Integrated Coastal Zone Management (ICZM) Project:** The Integrated Coastal Zone Management (ICZM) project aims to enhance coastal communities' livelihoods and preserve the coastal ecosystem. It identifies infrastructure needs and livelihood improvements and includes components like mangrove conservation and coastline mapping.
- **Coastal Regulation Zones (CRZ):** Coastal Regulation Zones (CRZ) were declared in 1991, encompassing areas influenced by tides up to 500 metres from the high tide line. The Ministry of Environment, Forest and Climate Change declares CRZ under the Environment Protection Act 1986.
- **Colour Coding of Cyclones:** The India Meteorological Department (IMD) issues a weather warning system using four colours (Green, Yellow, Orange, and Red) to indicate varying levels of cyclonic intensity and associated risks.

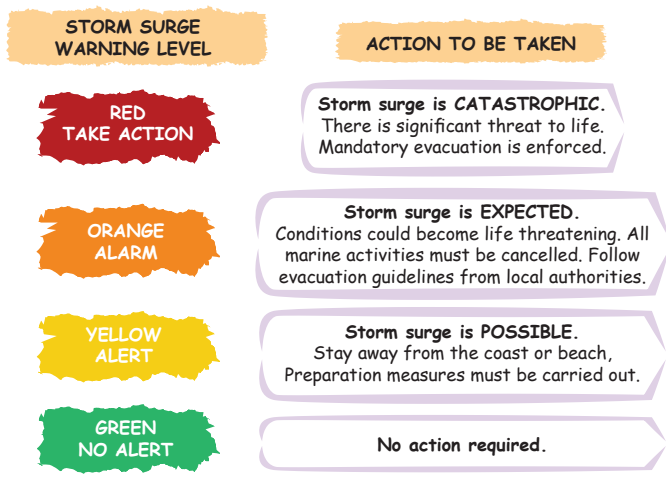


**Fig. 3.10:** Color-Coded Early Warning System For Cyclones

## Challenges of Cyclone Preparedness in India

- **Inadequate Response to Warnings:** Lack of planning and coordination at the national and local levels, leading to inadequate responses to cyclone warnings.



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- **Lack of Grassroots Participation:** Limited grassroots participation in disaster management, hinders the effective building of resilience.
- **Infrastructure Gaps at NDMA and MHA:** The absence of a fully automated and state-of-the-art operation centre at NDMA and MHA, with facilities for routine activities and disaster situations.
- **Need for Network Integration:** The necessity to integrate networks established by various agencies for comprehensive disaster management.
- **Evacuation and Shelter:** Ensuring the timely evacuation of people from high-risk areas to cyclone shelters is crucial but often faces logistical challenges, especially in densely populated regions.

### Way Forward

- **Nature based measures:** The administration must widen the cover under shelterbelt plantations and help regenerate mangroves in coastal regions to lessen the impact of cyclones.
- **Building cyclone-resilient infrastructure:** Constructing storm surge-resilient embankments, canals and improving river connectivity to prevent waterlogging in low-lying areas are important. Installing disaster-resilient power infrastructure in the coastal districts, providing concrete houses to poor and vulnerable households, and creating massive community awareness campaigns are essential.
- **Training Programs:** Training programmes for the disaster management officials and Non-Government Organisations (NGOs)should be arranged by the disaster management faculties of several management and public administration institutions in India.

### NDMA Guidelines on Cyclones (2008)

- **Early warning System:** Establishing a **state-of-the-art cyclone early warning system (EWS)** involving observations, predictions, warnings and user friendly advisories. Expanding the warning dissemination outreach by introducing 'Last Mile Connectivity', which will include providing a public address system along the entire coast line, using VHF technology.
- **National Disaster Communication Infrastructure**: Commissioning of the NDCI to provide dedicated and failsafe communications to the National, State and District Disaster Management Authorities and officials concerned.
- **National Cyclone Risk Mitigation Project:** Implementing the **NCRMP** in all the 13 coastal states and UTs.
- **Structural mitigation measures:** Improving structural lifeline infrastructure; construction of multi-purpose cyclone shelters and cattle mounds, ensuring cyclone resistant design standards in rural and urban housing schemes, building all-weather road links, bridges, culverts and saline embankments etc.
- **Management of coastal zones:** Mapping and delineation of coastal wetlands, patches of mangroves and shelterbelts and identification of potential zones for expanding bio-shield spread based on remote sensing tools.
- Setting up an **exclusive eco-system monitoring network** to study the impact of climate change.
- Setting up of a 'National Cyclone Disaster Management Institute' in one of the coastal states to address all issues related to cyclone risks.
- **Aircraft Probing of Cyclone (APC) facility:** Commissioning of APC facility to fill the critical observational data gaps and significantly reduce the margin of error in predicting cyclone track, intensity and landfall.

### Best Practices in Cyclone Mitigation Around the World

- **Cuba:** Renowned for its **community-based** preparedness system, Cuba actively engages citizens in disaster risk reduction, leading to remarkably low death tolls despite frequent hurricanes.
- **Netherlands:** This country's innovative coastal management system, including the **Delta Works,** protects its land from storm surges and high tides, serving as a model for other coastal nations.
- **Bangladesh:** Facing a double threat from cyclones and storm surges, Bangladesh has **developed innovative solutions like cyclone-proof housing** made from bamboo and earthen materials. They also utilize a network of cyclone towers as storm shelters and communication hubs, ensuring timely alerts and rescue efforts reach vulnerable areas.

## Drought

Droughts are characterised by a significant deficiency in water availability, primarily resulting from a lack of rainfall. These include traditional factors such as precipitation, evaporation, and evapotranspiration, as well as agricultural elements like groundwater levels, soil moisture, storage, surface runoff, and the types of crops grown.

### Causes of Drought in India

- **Insufficient Rainfall and Dry Weather:** According to the Ministry of Home Affairs, 68% of India is prone to varying degrees of drought. This includes 35% with rainfall between 750 mm and 1125 mm (considered drought-prone) and 33% with less than 750 mm (deemed chronically drought-prone).
- **Natural Factors:** Natural causes, such as variations in climate patterns, atmospheric conditions, and cyclic climate phenomena contribute to the occurrence of drought.

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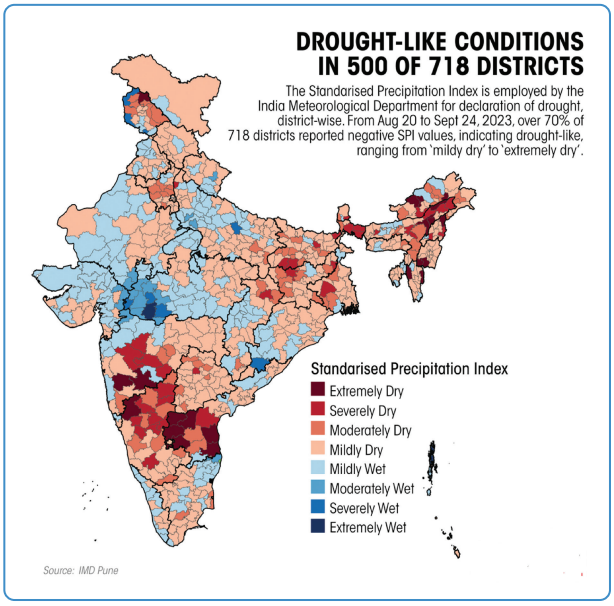


**Fig. 3.11:** Drought Prone Areas In India

- **Human-induced Factors:** Anthropogenic activities, including deforestation, urbanisation, and changes in land use, can disrupt natural water cycles and contribute to drought.
- **Supply-Demand Imbalances:** Increasingly, imbalances between water supply and demand, driven by population growth, agricultural practices, and industrial activities, play a significant role in causing drought.
- **Geographic Variability:** Geographic disparities in rainfall distribution, with some regions receiving inadequate precipitation, contribute to the development of drought conditions.
- **Monsoonal Patterns:** In regions dependent on monsoonal rainfall, variations in the timing, intensity, and duration of monsoons can lead to drought conditions.
- **Cultivation of Water-Intensive Crops:** Farmers, compelled by circumstances, engage in the production of water-intensive cash crops, such as the example of cultivating 'Mentha' in the drought-prone Bundelkhand region of Uttar Pradesh.

## Classifications of Drought Situations

The Indian Meteorological Department (IMD) recognises and categorises drought situations into five distinct classifications:

1. **Drought Week:** Defined as a period when the weekly rainfall is less than half of the normal expected amount.
2. **Agricultural Drought:** This occurs when four consecutive drought weeks are observed during the critical period from mid-June to September, impacting agricultural activities.
3. **Seasonal Drought:** Declared when the cumulative seasonal rainfall deviates significantly from the normal, exceeding the standard deviation.
4. **Drought Year:** Designated when the annual rainfall for the entire year falls short by 20 percent or more compared to the established normal levels.
5. **Severe Drought Year:** Designated when annual rainfall experiences a deficiency of 50% or more compared to normal levels.

**Drought-Prone Areas of India by Hydrology and Water Resources Information System**

| Sr. No. | State | Arid Area (sq km) | Semi-arid Area (sq km) |
|---|---|---|---|
| 1 | Rajasthan | 196,150 (57.31) | 121,020 (35.396) |
| 2 | Gujarat | 62,180 (31.72) | 90,520 (46.18) |
| 3 | Maharashtra | 1,290 (0.42) | 189,580 (61.61) |
| 4 | Madhya Pradesh | - | 59,470 (13.41) |

## Impacts of Drought in India

- **Human Impact:** The NITI Aayog's Composite Water Management Index (2018) report reveals that around two lakh people in India die annually due to inadequate water and sanitation, emphasising the severe consequences of water scarcity.
- **Economic Impact:** The NITI Aayog's report also projects a potential loss of 6% of India's GDP by 2050 as a result of a water crisis, highlighting the economic ramifications of insufficient water management.
- **Agricultural Productivity:** Drought has a direct and severe impact on agricultural production, affecting crop yields and leading to significant reductions in output. As per NIDM, drought-prone districts account for 42% of the country's cultivable lands, impacting the livelihoods of millions of farmers.
- **Small Farmers and Suicides:** Small and marginal farmers are particularly affected, threatening their food and livelihood security. Approximately 78% of farmers who committed suicide in the last decade were small farmers, with 76% dependent on rain-fed agriculture.
- **Agricultural Practices and Crop Patterns:** Drought influences changes in agricultural practices, including shifts in crop patterns, land use, and the adoption of more drought-resistant vegetation. Farmers may face challenges in choosing suitable crops during water shortages.
- **Migration and Displacement:** Prolonged drought conditions may lead to rural-to-urban migration as farmers seek alternative livelihoods. This can result

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in urbanisation challenges and increased pressure on already strained urban resources.

| Regional Classification Of Drought Severity In India | |
|---|---|
| Extreme Drought Affected Areas | ❑ **Geographical Coverage:** Most parts of Rajasthan, specifically areas west of the Aravali hills, including Marusthali and Kachchh regions of Gujarat.<br>❑ **Notable Districts:** Jaisalmer and Barmer in the Indian desert, characterised by an average annual rainfall of less than 90 mm. |
| Severe Drought Affected Areas | ❑ **Geographical Coverage:** Parts of eastern Rajasthan, major sections of Madhya Pradesh, eastern regions of Maharashtra, interior areas of Andhra Pradesh, Karnataka Plateau, northern parts of interior Tamil Nadu, and southern regions of Jharkhand and interior Odisha. |
| Moderate Drought Affected Areas | ❑ **Geographical Coverage:** Northern parts of Rajasthan, Haryana, southern districts of Uttar Pradesh, remaining areas of Gujarat, Maharashtra excluding Konkan, Jharkhand, and the Coimbatore plateau of Tamil Nadu, and interior Karnataka. |

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## Steps Taken by the Government

- **Manual on Drought Management:** The Ministry of Agriculture released the manual in November, 2009. The manual suggests **looking beyond the traditional drought management through famine codes** for dealing with situations of mass hunger and collective penury. It focuses on **plans which take into account all capabilities of the state to address the impact of drought** i.e., focus on mitigation measures, tapping newer technologies, enabling the systems to adapt to the new legal framework and including improvement and area development programmes in drought mitigation.
- **Drought Prone Areas Programme(1973-74) and Desert Development Programme(1977-78):** They aim at drought proofing and minimising desertification of fragile areas in the arid, semi-arid and dry-sub humid regions often affected by severe drought conditions and desertification.
- **National Rainfed Area Authority**: Set up in the Ministry of Agriculture to address the **issue of drought mitigation on a long term basis**. It comprises experts who provide knowledge inputs regarding systematic upgradation and management of the country's dryland and rainfed agriculture.
- The Ministry of Agriculture & Cooperation has also undertaken some other measures to address the drought management including:
  - **Implementation of water harvesting conservation,** artificial recharge of ground water.
  - Traditional water harvesting and conservation, water saving technologies like drip and sprinkler irrigation systems, improved water saving farm practices, long term irrigation management etc.
  - **Working towards convergence of lessons learnt from studies** carried out by multiple institutions working in related fields such as the Central Research Institute for Dryland Agriculture (CRIDA), International Crop Research for Semi-arid Tropics (ICRISAT), India Meteorological Department (IMD), National Remote Sensing Centre (NRSC) and Indian Council for Agricultural Research (ICAR), etc.
  - Exploring practices such as **harvesting cereal crops for fodder, supplemental irrigation** if feasible, and ensuring availability of seeds when alternative crops are beneficial with logistic support from state and district machinery.
  - **Maximising efficient use of available surface and groundwater in drought prone areas** i.e. resorting to drip and sprinkler practices wherever possible, particularly for commercial crops including fruit orchards.
  - Undertaking **construction of watershed structures** at the right place to enhance water recharge for life saving irrigation at critical stages of crop growth and during drought situations, and
  - Using optimally the services of Village Resources Centre established by Indian Space Research Organisation, ICAR, State Agriculture University and other organisations towards management of drought.

## Some Successful Initiatives in Drought Management by State Governments

**Mission Kakatiya in Telangana (2015):** Mission Kakatiya is a comprehensive program in Telangana focusing on the restoration of minor irrigation tanks. This initiative has successfully restored nearly 17,000 tanks, supplying collected rainwater to 19 lakh acres of agricultural land.

**Sujalam Sufalam in Gujarat (2023):** Sujalam Sufalam is an initiative in Gujarat that contributes to effective water management. The program aims to positively impact drought-prone areas in the state.

**Property Tax Rebate for Rainwater Harvesting in Madhya Pradesh:** Municipal corporations in Jabalpur, Indore, and Gwalior in Madhya Pradesh have granted a rebate on property tax for facilities implementing rainwater harvesting. This incentivizes the adoption of rainwater harvesting systems.

**Mukhya Mantri Jal Swavalamban Abhiyan Of Rajasthan (2016):** The "Mukhyamantri Jal Swavalamban Abhiyan,"



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launched in January 2016, in Rajasthan, aims to achieve water sustainability by benefiting 21,000 villages by 2020 through the Four-waters Concept (rainwater, groundwater, under-ground water & in situ soil moisture), emphasising community participation, water conservation, and creating self-sufficient drinking water units.

**Indigenous Solution To Drought/Water Management In West Bengal:** Farmers use a traditional method with water-filled vessels (Kalsi) and tiny holes near plants. This technique, sustaining a 7-8 foot plant with just one litre of water, prevents drying up during summer by maintaining nearby soil moisture. In Arsha (Shirkabad), farmers use stored riverside water, ploughing in the afternoon for dew absorption, maintaining soil moisture, and enabling sugarcane cultivation

**Kerala's Water Budget:** Kerala became the first state to implement a water budget in April 2023, addressing water scarcity. Led by the Centre for Water Resources Development, the budget focuses on managing water resources efficiently, involving local bodies for equitable distribution. Despite abundant water sources, regions face scarcity due to management issues, prompting the government's proactive measures.

**Fig. 3.12:** Drought Policy And Preparedness Process Under IDMP

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## Existing Challenges in Drought Management in India

- **Disparity in Data Collection and Efficiency:** According to NITI Ayog's CWMI-2019 report, groundwater estimates are primarily based on observation data from a limited number of wells (15,640 wells), whereas there are approximately 30 million groundwater structures in the country. This data disparity affects the accuracy of assessments.
- **Lack of Technology Utilisation:** Underutilization of remote sensing and geographic information systems (GIS) for real-time water data. Geo-tagging of every water asset, including borewells, and online monitoring of groundwater levels can significantly enhance water resource management.
- **Agricultural Water Efficiency:** According to the National Water Development Agency, India's farm water efficiency is among the lowest globally, with farmers using 3-5 times more water than their counterparts in China, Israel, and the United States for the same crop. States are urged to segregate agricultural power feeders for monitoring electricity consumption.
- **Groundwater Crisis and Legal Framework:** The legal framework tying water rights to land rights contributes to India's groundwater crisis. Maharashtra has taken steps to control groundwater extraction through legislation, requiring new wells to have accompanying recharge structures.
- **Pricing Water:** The absence of a rational and pragmatic policy for pricing water is identified as a challenge. Implementing a well-structured pricing system can encourage adequate investment in water infrastructure and ensure sustainable water management.

## Way Forward

- **Strengthening weather forecasting:** Improved weather prediction models and effective communication of drought risks to farmers and communities are crucial for early preparation.
- **Investing in drought monitoring:** Real-time data collection through remote sensing and ground sensors can provide critical information for proactive intervention.
- **Promoting micro-irrigation:** Shifting from traditional flood irrigation to drip irrigation and sprinkler systems can significantly reduce water wastage and improve crop yields.



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- **Revitalising traditional water harvesting systems:** Reviving and upgradation of age-old rainwater harvesting techniques like tankas and bunds can boost groundwater recharge and local water availability.
- **Promoting efficient water use in urban areas:** Implementing leak detection systems, rainwater harvesting in buildings, and greywater reuse can enhance water security in cities.
- **Adopting drought-resistant crops**: Encouraging farmers to diversify crops(Shree Anna/Millets) and cultivate varieties with lower water requirements can minimise agricultural losses during droughts.
- **Promoting agroforestry and soil conservation:** Planting trees and shrubs along with crops helps retain moisture in the soil, reduces erosion, and improves resilience to climate change.
- **Strengthening social safety nets:** Providing financial assistance, employment opportunities under schemes like MGNREGS, and insurance options can protect vulnerable communities from the economic impact of droughts.
- **Integrated water management:** Establishing a holistic framework for water resource management across sectors, including agriculture, industry, and domestic use, is crucial for efficient utilisation.

### NDMA Guidelines on Drought Management (2010)

- **State-level Drought Monitoring Cells (DMCs):** Establish state-level DMCs under Disaster Management Authorities to collaborate on vulnerability maps with the National Remote Sensing Centre.
- **Drought Management Control Room:** Set up a drought management control room, incorporating ICT for real-time information on droughts.
- **Watershed Development Approach:** Recommendation for the Government of India to undertake a watershed development approach through various programs.
- **Weather Stations and Cloud Seeding**: NDMA advises using moisture sensors in IMD's weather stations for soil moisture monitoring, leveraging ISRO's Village Resources Centers for drought management, and proposing a national cloud seeding policy for water scarcity.
- **Comprehensive Damage Assessment**: Assessment of damage in terms of agricultural production, depletion of water resources, livestock population, land degradation, deforestation, and human health.
- **Financial Support and Insurance**: Guidelines stress timely credit provision, including consumption loans, for income support during drought. The focus includes developing region-specific insurance products to mitigate the economic impact of drought.
- **Afforestation Measures**: Promote afforestation with specified plant species like Subabul, Casuarina and Eucalyptus and encourage bio-diesel plants like Jatropha and Pongamia.
- **Capacity Building and Training Program**: Promote national drought training, build capacity in PRIs/ULBs, and encourage awareness.
- **Early Agriculture Measures**: Provide subsidised seeds, promote short-duration varieties, and advocate inter-cropping, mulching and weeding for drought resilience.
- **Animal Welfare Measures**: Establish fodder banks, use tank bunds, and implement market interventions for stable fodder prices and resilient animal husbandry during droughts.

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### Reviving the Odi River in Bundelkhand

Fig. 3.13

### The Problem

- Odi River originates from Madansagarat, which is located in Katal area of Madanpur village of Mandwara development block in Lalitpur District.
- Decades of neglect and unsustainable water management practices led to:
  - **Reduced water flow:** Silting, encroachment, and deforestation choked the riverbed, hindering water flow.
  - **Depleting groundwater:** Over Reliance on groundwater for irrigation and domestic use further stressed the already fragile water resources.
  - **Drought and poverty:** Water scarcity crippled agriculture, leading to unemployment, migration, and food insecurity.



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**The Solution:** A three-pronged approach funded by MGNREGA was implemented:

- **Desilting and Check Dams**: Villagers, along with an NGO, manually removed silt from the riverbed and constructed check dams to trap rainwater and slow down the flow, promoting groundwater recharge.
- **Streambed Deepening and Bank Stabilization:** Deepening the streambed increased the water holding capacity, while planting native trees and grasses along the banks prevented soil erosion and stabilised the riverbed.
- **Community Engagement and Livelihood Promotion:** Villagers actively participated in the revival efforts, fostering ownership and a sense of responsibility. Additionally, initiatives like beekeeping and fish farming were introduced to generate income and diversify livelihoods.

**Impact:** Increased water flow, Improved groundwater levels, Agricultural boost: Environmental revival, Empowered communities:

**IGNITE YOUR MIND**

Urbanisation intensifies the impact of droughts. Can we redesign cities to embrace nature-based solutions like green roofs, rainwater harvesting systems, and permeable pavements?

## Heat Wave

A Heat Wave is a prolonged period characterised by significantly higher-than-normal temperatures, inducing physiological stress and potentially causing adverse health effects, including fatalities. The **World Meteorological Organization (WMO)** defines a heat wave as a period of five or more consecutive days during which the daily maximum temperature exceeds the average maximum temperature by at least five degrees Celsius.

### Marine Heatwave

India has recently experienced an intense Marine Heatwave (MHW) in the northern Bay of Bengal since June 28, 2023. MHWs are prolonged periods of unusually high Sea Surface Temperature (SST). In this case, the MHW led to higher evaporation rates, increased moisture in the atmosphere, and above-average rainfall in northwest India. The elevated sea surface temperatures influenced the formation and behaviour of depressions in the Bay of Bengal, impacting the trajectory of weather systems. This resulted in a concentration of rainfall in northwest India, deviating from the typical north-central pattern. MHWs not only affect rainfall patterns but also have broader ecological impacts, including coral bleaching, seagrass destruction, and fisheries disruptions.

### Causes of Heatwaves

- **Atmospheric Pressure Systems:** High pressure at ground level, most common in the summer months, creates heat waves. When high pressure accumulates over an area it results in the sinking of air through the atmosphere. The air compresses and heats up as it sinks. For every 100 metres the air is pushed downward, and the temperature increases by 1°C.
  - **Heat Domes:** High pressure can also result in a heat dome, exacerbating the heatwave. A heat dome is created when an area of high pressure stays over the same area for several days, trapping very warm air underneath. The dome traps air that would otherwise rise and cool before circulating back to the surface, resulting in the continual build-up of heat and reducing the chance of precipitation.
- **Lack of Cloud Cover:** Clouds act like a blanket, reflecting sunlight back into space and helping to keep the Earth cool. During heatwaves, there is often a lack of cloud cover, allowing more sunlight to reach the Earth's surface and contribute to the rising temperatures.
- **Dry Soil and Vegetation:** Dry soil and vegetation absorb less heat than moist areas. This means that during heatwaves, dry regions tend to experience even higher temperatures as the available sunlight is converted directly into heat.
- **Urban Heat Island Effect:** Cities are often warmer than surrounding rural areas due to the urban heat island effect. This phenomenon occurs because concrete, asphalt, and other materials in urban areas absorb and retain heat more effectively than vegetation. The trapped heat can then radiate outwards, further elevating temperatures in the city.
- **Climate Change:** Climate change is making heat waves more frequent, intense, and long-lasting. The planet's average temperature has been rising due to the increased greenhouse gas emissions from human activities. This warming trend is contributing to more extreme weather events, including heatwaves.

**IMD Criteria For Declaring Heat Wave In India**

| | |
|---|---|
| **Temperature Thresholds** | **For Plains:** Heat wave conditions are acknowledged only when the maximum temperature hits a minimum threshold of 40°C.<br>**Hilly Regions:** The criteria for recognizing heat wave conditions involve a minimum maximum temperature of at least 30°C. |
| **Departure from Normal Criteria** | **Heat Wave:** Departure from normal is 4.5°C to 6.4°C.<br>**Severe Heat Wave:** Departure from normal is greater than 6.4°C. |
| **Actual Maximum Temperature Criteria** | **Heat Wave:** Declared when the actual maximum temperature is equal to or exceeds 45°C.<br>**Severe Heat Wave:** Declared when the actual maximum temperature is equal to or exceeds 47°C. |

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### Heat Wave Risks in India

- **Increased Frequency:** The **State of India's Environment In Figures report** revealed that India experienced 280 heatwave days from March 11 to May 18, 2022, marking the highest number in 12 years.
- **Seasonal Vulnerability:** The typical heat wave season in India spans from April to June. During this period, states across northwest India, the Gangetic Plains, Central India, and the east coast are particularly susceptible to heat wave conditions.
- **Cover Most Parts of the Country:** According to the study conducted by Ramit Debnath and colleagues at the University of Cambridge, **Over 90 percent of India's total area is in the "extremely cautious" or "danger zone"** of being hit by heat waves which are becoming more frequent due to climate change.
- **Human Toll:** According to the National Disaster Management Authority (NDMA), heatwaves have been responsible for 24,223 deaths from 1992 to 2015 in various states. However, the actual death toll might be higher due to underreporting of heat-related illnesses, especially in rural areas.
- **Urban Heat Island Effect:** Urban areas, characterised by higher population density, industrial activities, and a concentration of buildings, tend to experience more intense heat. Cities often become heat islands, with temperatures rising higher than in rural areas.
- **Vulnerability of Weaker Sections:** Weaker sections of society, including those engaged in outdoor labour for livelihood, are at significant risk during heatwaves. Their vulnerability to adverse impacts such as dehydration, heatstroke, and sunstroke is heightened.
- **Urban-Rural Disparities:** Rural areas may face difficulties in accessing healthcare and resources during heatwaves, exacerbating the disparities in health impacts between urban and rural populations.

### Impact of Heat Waves

- **Heat Waves and Health:** Rapid rises in heat gain due to exposure to hotter than average conditions compromises the body's ability to regulate temperature and can result in a cascade of **illnesses, including heat cramps, heat exhaustion, heatstroke, and hyperthermia.**
- **Social impacts:** Extreme heat can lead to heat-related illness and death, particularly in **elderly populations, the poor, outdoor workers, and in urban areas.** For example, during the 2003 European heat waves an estimated 70,000 additional people died due to the heatwaves, and in the United Kingdom alone, the impact of this heat wave was estimated at £41M in health-related costs and productivity.
- **Economic impacts:** Globally, **2% of total working hours is projected to be lost every year, either because it is too hot to work or because workers have to work at a slower pace.** The agricultural sector, where 940 million people earn their livelihood, is set to be harder hit by hotter temperatures, pushing workers, crops and livestock past their physiological heat and drought tolerances. **In parts of India, changes to weather patterns and the resulting impacts on agriculture and other sectors are expected to translate into a 9% decrease in standards of living by 2050 assuming no adaptation.** A World Bank report suggests that by 2050, about 600 million Indians will live in places that could experience loss of living standards, which could cost 2.8% of the GDP, stalling efforts to pull large parts of the population out of poverty.
- **Ecological impacts:** Heatwaves, without concomitant increases in precipitation, can lead to water shortages and increased stress for plants, particularly in arid regions. This has the effect of reducing plant growth, the basis of energy production and the food chain, with an overall drying-out of the landscape.

**IGNITE YOUR MIND**

How will the escalating frequency and intensity of heatwaves reshape the landscape of mental health, requiring not just heat mitigation strategies but also robust mental healthcare systems equipped to deal with the "psychosis of the sun"?

### Steps Taken by the Government

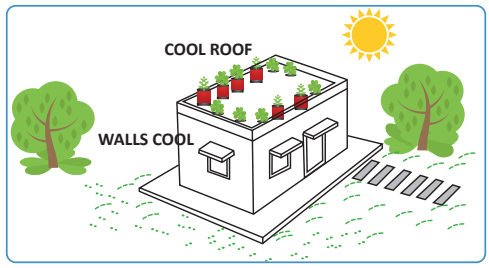


**Fig. 3.14:** NDMA's Cooling Solutions

- **India Cooling Action Plan (ICAP):** The ICAP echoes India's goal of providing sustainable cooling and thermal comfort for all while securing environmental and socio-economic benefits for society. It includes in its priority list the allocation of funds and support for a targeted program to enable cooling for economically challenged segments, such as cool roofs programs and localised heat action plans.
- **NDMA's Rulebook on Roof Cooling:** This handbook aims to guide homeowners with roof cooling solutions using techniques and materials that are affordable and easy to use in existing homes.
- **Heat Index (2023):** It is an IMD initiative, combining **temperature and humidity to calculate the apparent or "feel like" temperature for human comfort.** The Heat Index categorises apparent temperatures into colour-coded levels: Green (less than 35°C), Yellow (36-45°C), Orange (46-55°C), and Red (greater than 55°C). Launched experimentally, it serves as a vital tool for public health,



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guiding proactive measures during heatwaves and informing decision-making for community well-being.

**NDMA's Cooling Solutions For Existing Homes**

| | |
|---|---|
| Cool Roof | ❑ Bamboo/Thatch Screening<br>❑ Green Net Shading<br>❑ Roof Paint<br>❑ Gravel Roof<br>❑ Heat Insulation Tiles<br>❑ Hollow Concrete Tiles<br>❑ Broken China Mosaic<br>❑ Mud Phuska<br>❑ Lime Concrete<br>❑ Inverted Earthen Pots Extruded Polystyrene (XPS sheets)<br>❑ Modified Bitumen<br>❑ Cellulose Fibre<br>❑ Thermocrete<br>❑ Mist Cooling System |
| Cool Walls | ❑ Paints and Finishes |

- **National Heat Action Plan (NHAP):** Launched in 2015, NHAP provides a framework for state and local governments to develop specific action plans tailored to their region's vulnerabilities. These plans include early warning systems, public awareness campaigns, heat shelters, and medical emergency response protocols.
- **Urban greening:** Initiatives like the Smart Cities Mission promote planting trees and creating green spaces in cities to reduce the urban heat island effect.
- **Indian Institute of Tropical Meteorology (IITM):** This institute provides heat wave forecasts and monitors heatwave trends, aiding in preparedness and response efforts.

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## Challenges in Heat Wave Management

- **Insufficient Research at Sub-District Level:** Lack of research using sub-district level data hinders the development of separate indices for urban and rural areas, limiting targeted geographical interventions.
- **Limited Urban Ward-Level Analysis:** Narrow analysis of urban ward-level data restricts the identification of intra-city vulnerability patterns, impeding effective localised interventions.
- **Lack of Public Awareness:** Insufficient public awareness campaigns, including the promotion of traditional adaptation practices like staying indoors and wearing comfortable clothes, contribute to a lack of preparedness.
- **Inadequate Popularization of Design Features:** Half-hearted attempts to popularise simple design features, such as shaded windows, underground water storage tanks, and insulating housing materials, hinder broader adoption of heat-resistant measures.
- **Provisional Shortcomings for Drinking Water and Toilets:** Unavailability of provisions for drinking water within housing premises and indoor toilets exacerbates challenges during heat waves, impacting the well-being of individuals.

## Way Forward

- **Increasing Green Cover:** As suggested by NDMA, promoting afforestation and increasing urban green spaces can mitigate heat waves by providing shade and cooling effects.
  - **For Example**: Increasing the presence of natural vegetation in streets with low ventilation helps cool and improve air quality in urban areas.
- **Wetlands Expansion:** Ramsar Convention acknowledged that expanding and restoring wetlands helps regulate local temperatures and contributes to overall climate resilience.
- **Restoring Water Bodies:** Prioritising the restoration of ponds and lakes helps cool urban areas and provides additional green spaces.
- **Addressing Urban Heat Islands:** Reducing the urban heat island effect involves minimising heat-absorbing materials in infrastructure and construction, coupled with enhancing natural landscapes in urban areas.
- **Upgrading Building Standards:** Implementing standards that discourage the use of heat-absorbent materials in construction, such as galvanised iron and metal roof sheets, contributes to heat mitigation.
  - For example, Rajkumari Ratnavati Girl's School in Samalkha, Jaisalmer, employs innovative cooling techniques with an oval shape, strategic windows, and a solar canopy, ensuring cooling comfort in the desert heat.
- **Public Transportation Promotion:** Encouraging the use of public transportation reduces pollution and minimises heat emissions from individual vehicles, contributing to heat mitigation.
- **Effective Landfill Management:** Implementing waste segregation and solid waste management at the source reduces landfill fires, which can release methane and contribute to heat.

| NDMA Guidelines For Heat Wave Management | |
|---|---|
| Government Engagement | Mandate participation from state and district government leaders, municipal health agencies, disaster management authorities, and local partners for effective collaboration. |
| Appointment of State Nodal Agency and Officer | Appoint a State Nodal Agency and Officer to conduct tabletop exercises, simulations, and drills before the heating season, ensuring coordination among stakeholders. |
| Vulnerability Assessment and Threshold Temperatures | Conduct vulnerability assessment and establish Health threshold temperatures in coordination with IMD to set priorities and minimum thresholds for heat alerts and activities. |



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| | |
|---|---|
| **Development of Heat Action Plan** | Coordinate with the local IMD office to receive summer season forecasts and implement an early warning and daily alert system with colour codes. |
| **Team Preparation and Coordination** | Ensure state officials and agencies are well-trained and informed for pre-, during, and post-heat season activities, establishing a clearly defined inter-agency emergency response plan. |
| **Implementation and Monitoring** | Use Information, Education, and Communication to disseminate key messages in advance, including Do's and Don'ts during a heat wave, through various media channels, including social media. |
| **Evaluation and Plan Updating** | After each heat season, assess the efficacy of the heat action plan, evaluating processes, outcomes, and impacts to refine and improve the plan for subsequent years. |
| **Long-Term Strategies for Climate Change Adaptation** | Consider long-term mitigation strategies such as increasing green cover in cities to reduce the Urban Heat Island (UHI) effect and implementing cool roofs to adapt to climate change. |

### Case Study: Singapore's District Underground Cooling System (DUCS)

Singapore, **a densely populated island nation with a tropical climate, faces immense challenges in managing energy consumption and ensuring thermal comfort**. To address these issues, Singapore implemented the DUCS, a pioneering network of chilled water pipes supplying air conditioning to buildings. This case study explores the DUCS, its impact, and its potential as a model for sustainable urban cooling.

**About:** The DUCS is a centralised cooling system that produces chilled water at central plants and distributes it through underground pipes to connected buildings. These buildings use the chilled water to cool their air conditioning systems.

#### Impact

- **Energy Savings:** Compared to conventional systems, DUCS in Marina Bay saves an estimated 30% of energy annually, equivalent to the electricity consumption of 24,000 Singaporean households.
- **Reduced Emissions**: $CO_2$ emissions are reduced by an estimated 25,000 tons annually, contributing to Singapore's climate change goals.
- **Economic Benefits**: Building owners in Marina Bay benefit from lower operational costs and increased efficiency.

## Cold Wave

A cold wave is a weather phenomenon characterised by a significant cooling of the air or the influx of very cold air over a large region. It may entail a prolonged period of extremely cold weather, often accompanied by high winds leading to severe wind chills. Cold waves can be associated with notable winter weather events like blizzards or ice storms.

### Causes of Cold Waves

- **High-Pressure Systems and Subsidence:** High-pressure systems trap cold air near the ground, preventing it from rising and warming up. Additionally, subsidence, the downward movement of cool, dense air, further reinforces the cold temperatures.
- **Lack of Cloud Cover:** Clouds act like a cozy blanket for the Earth, trapping heat and preventing it from escaping into space. However, during cold waves, cloud cover is often scarce. This allows precious heat to radiate out, leaving the Earth feeling exposed and vulnerable to the bitter cold.
- **Snow and Ice Cover:** Snow and ice reflect sunlight back into space, preventing it from warming the ground. This cooling effect can contribute to colder temperatures, especially in regions with extensive snow cover.
- **Ocean Currents:** The ocean plays a crucial role in regulating Earth's climate. However, certain ocean currents can also influence cold waves. For example, the La Nina phenomenon, characterised by cooler-than-average sea surface temperatures in the equatorial Pacific Ocean, can lead to colder winters in some parts of the world.
- **Deforestation:** While not a direct cause, deforestation can exacerbate the effects of cold waves. Trees act like natural windbreaks, sheltering areas from harsh winds and helping to retain heat. When forests are cleared, these protective barriers are removed, making regions more susceptible to the biting chill of cold waves.

### Cold Wave Risk in India

- **Time of Occurrence**: In India, the cold wave (CW) conditions are generally experienced during the period from November to March However, the disaster data shows that the damages and casualties are associated with CWs during the months of December to March.
- **Absence of Cloud Cover:** Lack of clouds leads to reduced trapping of outgoing infrared radiation, resulting in colder ground temperatures.
- **Snowfall in the Himalayas:** Cold winds from snowfall in the upper Himalayas contribute to the cold wave.
- **Subsidence of Cold Air:** Downward movement of cold and dry air close to the surface.
- **La Nina:** In the winter months, the La Nina causes a very cold wave-like jet stream to flow across Afghanistan,

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Iran and the Hindu Kush mountains. These strong and cold winds impact the degree of cold in India.

- **Western Disturbances:** Weather systems originating in the Mediterranean Sea, bring cold winds and precipitation, leading to cold wave conditions in northwest India.
- **Wind Chill Factor:** The wind chill factor, influenced by wind speed, gauges how cold the air feels by accelerating heat loss from the human body, often making the temperature seem lower than the actual reading.

**IMD Criteria for Cold Wave**

| Criteria | Temperature Conditions |
|---|---|
| Cold Wave Criteria | **Plains:** Minimum temperature 10°C or less<br>**Hilly regions:** Minimum temperature 0°C or less |
| Departure from Normal | **Cold Wave:** Negative departure from normal is 4.5°C to 6.4°C<br>**Severe Cold Wave:** Negative departure from normal is more than 6.4°C |
| Actual Minimum Temperature (For plain stations only) | **Cold Wave:** Minimum temperature is ≤ 4°C<br>**Severe Cold Wave:** Minimum temperature is ≤ 2°C |
| Cold Wave Conditions for Coastal Stations | When the minimum temperature departure is -4.5°C or less over a station, "Cold Wave" may be described if the minimum temperature is 15°C or less. |

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## Impacts of Cold Waves in India

- **Agricultural Impacts**: Cold waves in northern India during the winter damages crops, including wheat and mustard, leading to significant losses for farmers. Extreme cold can affect crop growth, delaying or reducing yields.
  - **Impact on Horticulture:** Cold waves can affect horticultural crops. In regions where temperatures drop significantly, fruits and vegetables may be damaged, impacting both local consumption and market supplies.
  - **Livestock Vulnerability:** Livestock, especially in rural areas, face risks during cold waves. Farmers may need to take measures to protect animals from the cold. Extreme cold conditions can lead to livestock losses.
- **Health Consequences:** Severe cold waves in North India, particularly in states like Uttar Pradesh and Bihar, have led to an increase in cases of hypothermia and frostbite. Homeless populations are particularly vulnerable, with instances of cold-related deaths reported. Ministry of Statistics and Programme Implementation's Environmental Statistics report show that on an average, over 800 people loses their lives every year due to exposure to the cold
- **Energy Consumption Surge:** During cold waves, there is a surge in energy consumption for heating purposes. In January 2021, North India experienced a cold wave, leading to increased demand for electricity and fuel for heating appliances.
- **Transportation Disruptions:** Cold waves can impact transportation. Cold waves in winter disrupt travel in northern India, leading to the cancellation and delay of numerous flights and trains. Icy roads can also pose risks to commuters.
- **Social and Economic Disruptions:** Closure of schools and businesses is not uncommon during severe cold waves. The January 2023 cold wave in North India resulted in the shutdown of schools and affected businesses, causing economic disruptions.
- **Water Supply Challenges:** Freezing temperatures can lead to the freezing of water pipelines, causing bursts and disruptions in water supply. In January 2018, parts of northern India faced water supply challenges due to cold-related issues.
- **Increased Pollution Levels:** Health risks due to cold waves also heighten in areas where air pollution is severe. A 2018 study conducted by researchers from Banaras Hindu University and St Johns Medical College in Bengaluru has found that mortality increases by 30 per cent during extreme temperature days. **This increases by another 8 per cent during winters in areas with high concentration of air particulates (PM10) compounds.**

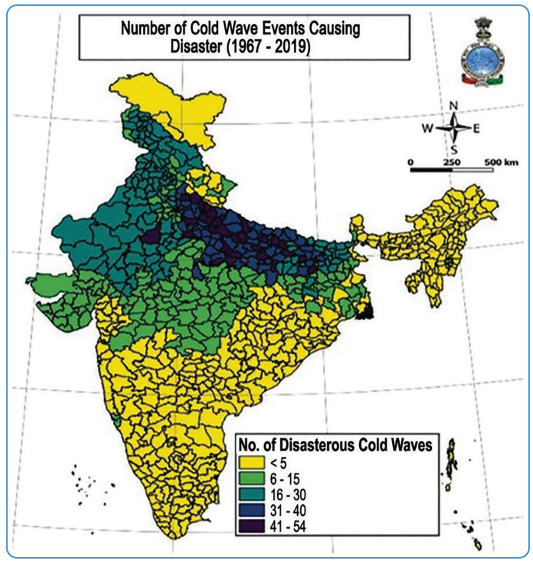


**Fig. 3.15:** Cold Waves In India From 1967-2019

## Steps Taken by the Government

- **Notified Disaster:** Cold wave is already included in the list of 12 disasters notified in the Guidelines on Constitution and Administration of the State Disaster Response Fund (SDRF) and National Disaster Response Fund (NDRF)



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- **Common Alerting Protocol (CAP):** Government has initiated a project called "Common Alerting protocol (CAP) based integrated Alert System (Sachet Phase-I)" for dissemination of early warning/alert regarding disasters to the public including heat waves and cold waves.
- **Measures by states: Uttar Pradesh** government has **allocated Rs 120** crore to the relief department for providing temporary accommodation, food, clothing and medical facilities for the destitute.

### Way Forward

- **Increased Governance efficiency:** District disaster management centres need to be strengthened further in terms of logistics, infrastructure, manpower and other crucial things that are prerequisites for the robust DRR setup.
- **Medical Preparedness:** Ensure hospitals and clinics have adequate stocks of medicines, warm clothing, and resources to treat cold-related illnesses like hypothermia and pneumonia.
- **Climate-Resilient Infrastructure:** Invest in better insulated homes, especially in vulnerable regions, to retain heat and reduce energy consumption.
- **Urban Planning:** Promote green spaces and tree cover in cities to regulate temperatures and provide windbreaks.
- **Cautious warming:** The heat resources used by people can sometimes trap them in some other disasters for example there have been many instances where people have been using coal for burning and generating heat in closed room environments where there is no ventilation or very limited ventilation available in those cases this production of carbon monoxide actually affects their health also causes sometimes casualties of the human beings. **People need to be sensitised properly on the use of heat resources so that there is no side effect on their health.**

| NDMA Guidelines on Cold Wave | |
|---|---|
| **Early Warning and Communication** | Utilising forecasts, impact-based warnings, and efficient communication for timely dissemination of information, facilitating a swift response and minimising the impact of cold waves. |
| **Dealing with Cold Wave and Preparing Action Plan** | Integrating cold wave management into disaster frameworks, justifying action plans, defining objectives, and outlining key strategies, including acclimatisation measures. |
| **Prevention and Mitigation Measures** | Addressing preventive strategies and sector-wise mitigation measures to reduce the occurrence and impact of cold waves. This includes community, family, and sector-specific actions. |
| **Preparedness and Response Measures** | Providing guidance on community and family preparedness during cold waves, empowering individuals to respond effectively to extreme cold conditions. |
| **Information Education and Communication (IEC)** | Outlining key components of IEC strategies, activities, and campaigns to effectively disseminate warning messages, ensuring public awareness and preparedness. |
| **Capacity Building and Training** | Emphasising the importance of capacity building and training programs, specific measures, and identifying a nodal agency for enhancing the capabilities of stakeholders in managing cold waves. |

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## Thunderstorms, Hailstorms and Dust Storm

Among the emerging weather hazards, Thunderstorms and lightning, Squall, Dust storms, hailstorms, and Strong Winds pose significant threats, impacting agriculture, aviation, transportation, power, and socio-economic sectors. With a population density of approximately 142.8 crore, the vulnerability is heightened. Experts predict an increase in the frequency and severity of these incidents due to global temperature rise and climate change.



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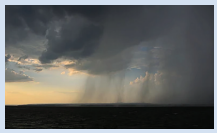
| Definitions of The Terminologies | |
|---|---|
| **Thunderstorm** | ❑ A weather event characterised by the occurrence of thunder or the sight of lightning. **Audible thunder can be heard up to 40 km from the source.**<br>❑ Classified into moderate (loud thunder, moderate to heavy rain, wind speed 29-74 kmph) and severe (continuous thunder, occasional hailstorm, wind speed >74 kmph).<br>❑ Lightning and thunder are dependent on each other but they are separate events. **Lightning is electrical energy while thunder is sound energy.** |
| **Lightning** | ❑ **Luminous electrical discharge** accompanied by thunder. Classified into Thundercloud or Intra-cloud (within clouds), Cloud-to-cloud or Inter-cloud (between clouds), and Cloud-to-ground (strikes the ground). Cloud-to-ground lightning poses a higher risk, with high peak power, temperature and current. |
| **Squall**  | ❑ A sudden increase in wind speed, at least 29 kmph, lasting for one minute.<br>❑ Classified into moderate (wind speed up to 74 kmph) and severe (wind speed >74 kmph). |
| **Hailstorm** | ❑ Weather events are characterised by the fall of hail. Classified into slight (sparsely distributed, small size), moderate (abundant enough to whiten the ground), and strong (includes large stones) based on intensity. |
| **Dust Storm** | ❑ Convective storms in northwest India during the pre-monsoon season. Classified into slight (wind speed up to 41 kmph, visibility 500-1000 metres), moderate (wind speed 42-74 kmph, visibility 200-500 metres), and severe (wind speed >74 kmph, visibility <200 metres). |

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## Causes of Lightning, Hailstorms, and Dust Storms in India

### Lightning

In the early stages of development, **air acts as an insulator between the positive and negative charges in the cloud** and between the cloud and the ground. When the opposite charges build up enough, this insulating capacity of the air breaks down and there is a rapid discharge of electricity that is called lightning. The flash of lightning temporarily equalises the charged regions in the atmosphere until the opposite charges build up again. Lightning can occur between opposite charges within the thunderstorm cloud (intra-cloud lightning) or between opposite charges in the cloud and on the ground (cloud-to-ground lightning).

### Hailstorm

High up in a storm cloud, it's so cold that small pieces of ice can form. The winds within the storm cloud can cause the ice to swirl around. When it bumps into cold water droplets, the water freezes onto the ice, making hail grow larger. Eventually, the hail is so big and heavy that it falls to the ground.

### Dust storm

Dust storms are caused by very strong winds — often produced by thunderstorms. In dry regions, the winds can pull dust from the ground up into the air, creating a dust storm. An area's geography and plant life can also make it more likely to have dust storms. For example, dust storms are common in regions that are flat and have very few trees and plants. These two features allow winds to build up momentum, causing the winds to grow stronger and drive more dust into the atmosphere.

## Risk of Lightning, Hailstorms and Dust Storms in India

### Lightning

- **State Wise Distribution:** Lightning frequency is highest in **northeastern states and West Bengal, Jharkhand, Odisha, Bihar and Sikkim.** However, the number of lightning-related deaths is higher in central Indian states like Maharashtra, Chhattisgarh, Madhya Pradesh and Odisha.
  - **More risk in plain areas:** Lightning characteristics are different for different regions, the prevalence is more at night and the early hours in hilly States and **more**



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**during the day in the plains.** That is why deaths occur more in the plains

- **Climate Change:** In India, a 2021 study published in the journal 'Atmospheric Chemistry and Physics' said that by the end of the century, **lightning frequency is set to rise by between 10% and 25%,** while its intensity is expected to increase by between 15% and 50%.
- **Low Mitigation efforts:** As per experts India suffers huge human casualties from lightning compared to developed countries. According to 2016 research published by Vaisala, **about two people in a million die from lightning in India each year, yet in the U.S. and Australia, for example, that figure is 0.1 per million.**
- **Increasing Intensity:** According to a study by the non-profit Climate Resilient Observing Systems Promotion Council India recorded more than **18 million lightning strikes between April 2020 and March 2021. This was a 34% rise over a similar period during the previous year.**

### Hailstorm

- **High-Risk Areas:** Maharashtra, Vidarbha region, Madhya Pradesh, Uttar Pradesh, Himachal Pradesh, and West Bengal are particularly susceptible to hailstorms, experiencing more frequent and intense occurrences compared to other regions.
- **Geographical Features:** The Deccan Plateau and the Himalayan foothills provide ideal conditions for the formation of cumulonimbus clouds, which are necessary for hailstorms. Strong updrafts within these clouds, combined with low temperatures and rapid changes in pressure, lead to the formation and growth of hailstones.
- **Climate Change:** Rising temperatures and alterations in atmospheric circulation patterns are likely contributing to increased hailstone size and frequency in some regions.

### Dust Storm

- **High-Risk Areas:** The western states of Rajasthan, Gujarat, and Haryana are most susceptible to dust storms due to their arid landscapes, sparse vegetation, and strong winds. Other vulnerable regions include Punjab, Uttar Pradesh, Delhi, and Madhya Pradesh.
- **Geographical Features:** The Thar Desert in western India acts as a major source of dust particles, contributing to dust storms affecting surrounding regions.
- **Land Degradation:** Overgrazing, deforestation, and unsustainable agricultural practices lead to soil erosion and increase the amount of loose soil available to be transported by wind.
- **Seasonal Variations:** Dust storms primarily occur during the pre-monsoon months (March-May) when dry winds whip up loose soil particles from parched landscapes. However, they can also occur sporadically during other seasons.

## Impact of Lightning, Hailstorms and Dust Storm

### Lightning

- **Human Loss:** According to the National Crime Records Bureau (NCRB), in the year 2021, as many as **2,880 people died due to lightning. As per** NDMA on an average 2,500 people die due to lightning annually.
- **Economic Losses:** Lightning strikes can damage infrastructure, disrupt power grids, and cause agricultural losses, impacting the livelihoods of millions.
- **Health Risks:** Survivors of lightning strikes can suffer long-term health consequences, including neurological damage, burns, and psychological trauma.
- **Social Vulnerability:** Certain communities, such as farmers, construction workers, and outdoor vendors, are disproportionately affected by lightning due to their exposure during their work.

### Hailstorm

- **Crop damage:** Hailstones can severely damage crops like fruits, vegetables, and cash crops, leading to substantial economic losses for farmers. The impact can range from bruising and scarring to complete destruction of the crop.
- **Livestock injuries:** Hailstones can injure or even kill livestock in open fields, further adding to the losses for farmers.
- **Disruption of power and communication lines:** Hailstones can damage power lines and communication networks, leading to disruptions in electricity supply and communication services.
- **Soil erosion:** Heavy hailstorms can lead to soil erosion, further degrading vulnerable landscapes and reducing agricultural productivity.

### Dust Storm

- **Environmental:** The fertilising effect of desert dust is thought to have an impact on algal blooms, some of which can be harmful, and may contribute to *Sargassum* seaweed mats. These drifting seaweed mats provide important habitat for many species in the open ocean, but close to shore, they can disrupt shipping, fishing and tourism.
  - **Impact on corals:** Potential links have also been identified between microorganisms, trace metals and organic contaminants carried in desert dust. Disease has undoubtedly been an important factor in recent coral reef declines worldwide and several of the diseases that affect corals are associated with microorganisms carried in desert dust.



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- **Health:** Fine dust particles can irritate lungs and airways, triggering asthma attacks, respiratory infections, and other breathing difficulties, especially for vulnerable populations like children, the elderly, and those with pre-existing conditions.
- **Economic:** Dust storms can damage crops and deter tourists, impacting the economic well-being of communities dependent on these sectors.

## Steps Taken by the Government

### Lightning

- **Early Warning:** India Meteorological Department (IMD), **issues forecast and warnings for thunderstorms and associated weather phenomena five days in advance with regular updates.** Indian Institute of Tropical Meteorology(IITM), Pune, an autonomous research institution under the Ministry of Earth Sciences(MoES), has **established a lightning location network, strategically installed at 83 places in the country to detect and locate lightning strikes with utmost accuracy.** The output from this network is shared with IMD and various State Governments and is used for forecasting purposes.
- **'Damini' lightning App:** Developed by IITM-Pune. The App is monitoring all lightning activity which are happening over India and alerts the person if lightning is happening in the area near the person, by GPS notification under 20KM and 40KM radius. It also provides a lightning warning at the location valid for the next 40 minutes.
- **Financial Help:** As per the guidelines issued based on recommendations for the 15th Finance Commission for Constitution and Administration of State Disaster Response Fund (SDRF)/ National Disaster Response Fund (NDRF), **lightning is not included in the centrally notified list of natural disasters eligible for relief under SDRF/NDRF.** However, the State Governments can use up to 10% of the annual funds allocation of their SDRF, for providing immediate relief to the victims of natural disasters that they consider to be 'disasters' within the local context in the State, including lightning. As per approved norms, an ex-gratia of Rs. 4.00 lakh is provided to the next-of-kin of a person who died due to a notified disaster.
- **Kerala State Lightning Action Plan:** Action plan lists risk-reduction measures to be adopted by Government departments/agencies, long and short-term mitigation measures for the State, scientific aspects of the natural phenomenon and standard precautions.

### Hailstorm

- **Anti-Hailstorm Guns:** To help out horticulturists who face crop damage due to hailstorms, the Himachal Pradesh government will be testing the use of indigenously developed 'anti-hail guns. An anti-hail gun is a machine which generates shock waves to disrupt the growth of hailstones in clouds
- **Weather forecasting and monitoring:** The India Meteorological Department (IMD) has a network of radars, automatic weather stations, and Doppler radars to monitor atmospheric conditions and issue timely hail storm warnings. These warnings are disseminated through various channels like mobile apps, SMS, radio, and TV.
- **Hailstorm Nowcasting system**: IMD recently developed the Hailstorm Nowcasting system for real-time prediction of hailstorms within a short timeframe (60-90 minutes) in vulnerable areas. This allows for more targeted warnings and immediate precautionary measures.
- **Pradhan Mantri Fasal Bima Yojana (PMFBY):** This scheme provides financial support to farmers in case of hail-induced crop damage, helping them mitigate losses and recover more quickly.

### Dust Storm

- **National Action Plan to Combat Desertification:** Launched in 2001, this plan aims to restore degraded land and prevent desertification, thereby reducing dust storm sources. It promotes sustainable land management practices like afforestation, soil conservation, and rainwater harvesting.
- **National Afforestation Programme:** This program focuses on increasing forest cover, which helps bind soil and reduce wind erosion, a major dust storm contributor.
- **Integrated Watershed Management Programme:** This program promotes holistic watershed management practices, including soil conservation and water resource management, which contribute to long-term land health and reduced dust storm risks.
- **National Mission for Green India (GIM):** It aims at protecting; restoring and enhancing India's diminishing forest cover and responding to climate change by a combination of adaptation and mitigation measures.
- **Fodder and Feed Development Scheme:** Component of Grassland Development including Grass Reserves, Command Area Development and Water Management (CADWM) programme etc.

## Challenges in Lightning, Hailstorms and Dust Storm Mitigation

### Lightning

- **Geographic and Demographic Constraints:** India's diverse landscape, with mountainous regions and vast rural areas, makes it challenging to deploy and maintain extensive early warning systems and infrastructure.

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Reaching geographically isolated communities with awareness campaigns and safety measures presents an additional hurdle.

- **Policy Lapse:** Lightning is not included in the centrally notified list of natural disasters eligible for relief under SDRF/NDRF despite most common reason for deaths by forces of nature (35.3%)(NCRB)
- **Environmental degradation and climate change:** The CROPC-IMD report said that rapid degradation of the environment like global warming, deforestation, depletion of water bodies, concretisations, rising pollution and aerosol levels have cumulatively pushed the environment to extremes. Lightning is the direct promulgation of these climatic extremities.
- **Major incidents in poor states:** The Odisha-West Bengal-Jharkhand belt is more prone as lightning strikes originate from Chota Nagpur Plateau and extend to Bangladesh to Patkai plateau of Meghalaya.
- **Lack of Awareness and Preparedness:** Many communities, particularly in rural areas, lack awareness about lightning safety practices and precautions

### Hailstorm

- **Limited Prediction Accuracy:** Predicting the exact location, size, and duration of hailstorms remains difficult, hindering timely warnings and preventative measures.
- **Vulnerable communities:** Rural populations, often lacking access to information and resources, may not be aware of hailstorm risks or effective safety measures. Reliance on traditional practices and beliefs about hailstorms can sometimes contradict scientific advice, limiting the effectiveness of preventive actions.
- **Fragile agricultural practices:** Traditional farming techniques may leave crops vulnerable to hailstorm damage, impacting food security and livelihoods.

### Dust Storm

- **Addressing land management practices:** Unsustainable agricultural practices, overgrazing, and deforestation contribute significantly to dust generation. Encouraging sustainable land management techniques, such as afforestation, cover cropping, and soil conservation practices, is essential.
- **Overcoming economic and social constraints:** Implementing mitigation measures often involves costs and may require changes in livelihoods and traditional practices. Addressing these concerns through economic incentives, community involvement, and capacity building is crucial.
- **Limited infrastructure and technology**: Implementing effective dust control measures like wind fences, vegetative barriers, and dust suppressants requires resources and expertise. Bridging the gap in infrastructure and technological know-how is essential.
- **Institutional coordination and policy coherence**: Dust storms often transcend state and regional boundaries. Effective mitigation requires coordinated efforts and consistent policies across different levels of government.
- **Climate change and its impact:** Dust storms are expected to become more frequent and intense due to climate change. Integrating dust storm mitigation into broader climate adaptation strategies is necessary for long-term resilience.

## Way Forward in Mitigating Climate Change Lightning, Hailstorms and Dust Storm

### Lightning

- **Lightning be declared as a "natural disaster":** According to present norms, cyclone, drought, earthquake, fire, flood, tsunami, hailstorm, landslide, avalanche, cloudburst, pest attack, frost and cold waves are considered as disasters that are covered under the State Disaster Response Fund (SDRF), 75% of which is funded by the Centre.
- **Micro-Zonation: Annual Lightning Report 2020-2021** recommended that states should undertake lightning micro-zonation for geographical region wise precise handling of the risk. The Lightning Risk Management programme for each state has to be customised according to seasonality, intensity and frequency of lightning.
- **Organise lightning safety drills and awareness campaigns:** Engage local communities in preparedness activities to ensure they are well-equipped to handle lightning emergencies.
- **Nature solutions:** Promote the planting of trees that are less likely to be struck by lightning. Certain species like neem and peepal have lower conductivity and can offer some protection.

### Hailstorm

- **Invest in advanced Doppler radars and hailstone detection technology:** Precise hailstone size and location prediction can give farmers and communities precious time to prepare.
- **Sustainable agricultural practices and crop diversification**
  - **Encourage planting hail-resistant crop varieties:** Promote research and development of resilient hybrids and educate farmers about available options.
  - **Adopt sustainable agroforestry practices:** Planting trees around fields can act as windbreaks and disrupt hailstone formation.
  - **Diversify crops:** Encourage farmers to plant a variety of crops with different maturity times to minimise losses in case of hailstorms.

### Dust Storm

- **Agriculture:** Installing sand fences near agriculture areas, planting trees or shrubs to block the movement of sand and dust, deploying equipment and personnel to clear



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irrigation and drainage channels from sand, changing harvesting or planting procedures and timing to avoid the impact of moving sand.

- **Mapping and characterising dust sources:** Accurately pinpointing areas prone to soil erosion, like overgrazed pastures and arid regions, is crucial for targeted interventions.
- **Promoting sustainable land management**: Encouraging practices like afforestation, cover cropping, and soil conservation techniques stabilise vulnerable landscapes and reduce dust generation. e.g. **The Great Green Wall Project adopted by the African Union.**
- **Capacity building and livelihood diversification:** Equipping communities with skills and resources to adopt sustainable practices and explore alternative income sources builds long-term resilience.

**NDMA Guidelines On Thunderstorms, Hailstorms And Dust Storms**

| Aspect | Description |
|---|---|
| **Government Engagement** | Active participation of various government bodies, including state and district administration, line departments, municipal authorities, health agencies, disaster management authorities, and local partners. |
| **Appointing a Nodal Department and Officers** | The state appoints nodal officers at both state and district levels and designates an agency to oversee the action plan's implementation. Capacity-building initiatives include training key officials and conducting exercises to address communication gaps. |
| **Vulnerability Assessment and Early Warning System** | Identification of vulnerable areas, assets, and populations. Priority areas for early warning, forecasting, and alert activities are established. Coordination with the Indian Meteorological Department (IMD) to develop reliable and accurate localised early warnings. |
| **Drafting and Developing the Action Plan** | Coordination with concerned line departments to formulate an action plan. Roles and responsibilities for all stakeholders are clearly defined. |
| **Team Preparation and Coordination** | State officials and agencies undergo preparation, training, and information dissemination for thunderstorms and lightning seasons. Development of an inter-agency emergency response plan with clearly marked roles and information flows. |
| **Implementation and Monitoring** | Government departments and partners are responsible for implementing various components of the action plan. Public awareness is crucial, and Information, Education, and Communication (IEC) play a significant role in disseminating key messages to communities. |
| **Strategies for Adapting to Climate Change (Long-term plans)** | Encouragement for states to undertake mitigation strategies to reduce the impact of climate change on extreme weather incidents. This may include developing disaster-resilient infrastructure and implementing guidelines for hazard-resistant construction. |

## Forest Fire

Forest fire may be defined as an unclosed and freely spreading combustion that consumes the natural fuels. When a fire burns out of control it is known as Wildfire. There have been forest fires throughout historic time ignited and burned naturally through the forest. Fire effects on forests however are not equal. Fire may be beneficial for one ecosystem and may be dreadful for the other, depending upon the climatic conditions and type of vegetation. Each year, millions of hectares of the world's forests are consumed by fire, which results in enormous economic losses because of burnt timber; degraded real estate; high costs of suppression; damage to environmental, recreational and amnesty values; and loss of life.

### Causes of Forest Fires

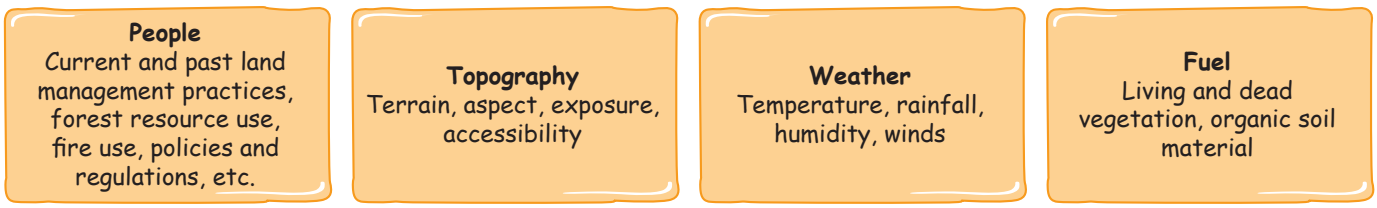


**Fig. 3.16:** Various igniting factors for forest fires



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- **Natural causes:** Lightning, volcanic eruptions, and spontaneous combustion of dry vegetation are some of the natural causes of forest fires. For instance **Uttarakhand Forest Fire (April-May 2016)**, fire was triggered by a prolonged dry spell and high temperatures, and was aggravated by the presence of pine needles, which are highly flammable.
- **Human causes:** Human activities are a major contributor of forest fires across the globe - Smoking, campfires, machinery, bullets, petroleum products, electric faults, and arson are some of the human causes of forest fires. Some people also deliberately start fires for land clearing, agriculture, hunting, or other purposes. For example Fires in the Bandipur National Park, Karnataka (February 2019), Fire in the Similipal Biosphere Reserve, Odisha (February-March 2021), Fire in the Similipal National Park in Odisha between February-end and early March 2021 all are suspected to be caused by human negligence. According to a forest research Institute document 95% of the forest fires are caused by human negligence.

### Risk of Forest Fire in India

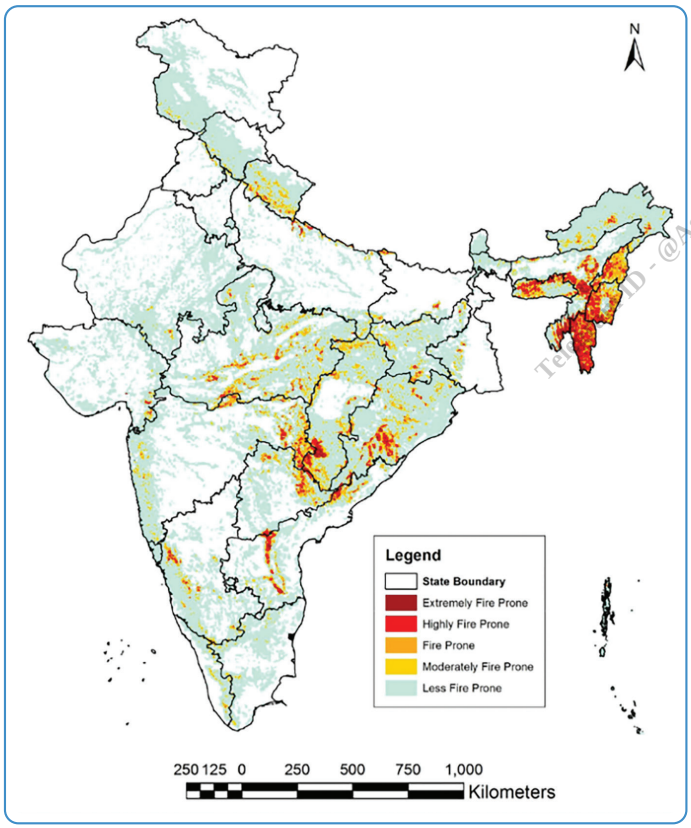


**Fig. 3.17:** Forest Prone areas in India

- **Proneness: According to the Forest Survey of India 2019,** More than 36% of the country's forest cover has been estimated to be prone to frequent forest fires of which **Nearly 4% of the country's forest cover is extremely prone to fire** The number of forest fires detected using satellite data increased from 52,785 in 2020 to 3,45,989 in 2021.
- **Frequency:** Based on the forest inventory records, **54.40% of forests in India are exposed to occasional fires, 7.49% to moderately frequent fires and 2.40% to high incidence levels while 35.71% of India's forests** have not yet been exposed to fires of any real significance.
- **Fire Clusters**: Broadly four fire clusters have been recognised in India.
  - **North-West Himalaya:** This region encompasses Jammu & Kashmir, Himachal Pradesh, Uttarakhand, and parts of Uttar Pradesh. The presence of **coniferous forests(Pines) with high fuel loads, steep slopes, and dry conditions in the pre-monsoon months makes them highly susceptible to wildfires.**
  - **North-East India:** Comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura, this region **experiences high fire frequency due to shifting cultivation practices(Slash and burn), bamboo flowering, and dry pre-monsoon winds.**
  - **Central India:** Covering Madhya Pradesh, Chhattisgarh, Odisha, Jharkhand, and parts of Andhra Pradesh and Maharashtra, this region experiences high fire occurrences **due to deciduous forests with high fuel loads, dry periods, and tribal practices of using fire for land clearing.**
  - **Western Ghats:** Stretching across Maharashtra, Goa, Karnataka, Kerala, and Tamil Nadu, these mountains experience fires due to a combination of factors like dry pre-monsoon winds, steep slopes, presence of fire-adapted species like Shola forests, and human activities like tourism and honey collection.

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### Impact of Forest Fire

- **Loss of biodiversity:** Forest fires tend to wipe out many flora and fauna, some of which may be rare or native to a specific area. Forest fires also lower the genetic variation of the forest ecosystem, making it more susceptible to diseases and pests. Terminalia chebula, T. bellirica, T. tomentosa **which have highly commercial and medicinal value respectively are facing severe problems** due to forest fire leaving behind poor stocking. Species like Lantana camara, L. indica, Eupatorium glandulosum, Parthenium hysterophorus, Cassia tora, C occidentalis, etc, have invaded several of the significant sites of forest biodiversity conservation.
- **Soil erosion and degradation:** Forest fires create a deficit of organic matter and nutrients in soil, leaving it vulnerable to water and wind erosion. This results in low soil quality, reduced water-holding capacity, and carbon storage potential. In February 2019, **forest fire in the Bandipur Tiger Reserve and National Park in 2019 destroyed nearly 40,000 acres killing a forest guard and injuring many others.**



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- **Economic losses and social conflicts:** Forest fires harm valuable timber and non-timber forest products, affecting the livelihoods of millions of people who depend on them. According to a World Bank report **India is losing at least ₹ 1,100 crore due to forest fires every year.**
- **Air pollution and health hazards:** Forest fires release large amounts of smoke, particulate matter, and greenhouse gases, which affect the air quality and climate. The smoke can cause breathing problems, eye irritation, and allergies for humans and animals. The greenhouse gases contribute to global warming and climate change.
- **Positive Feedback Loop:** Increased temperatures and changing climate conditions can lead to more frequent and severe wildfires, creating a feedback loop that contributes to climate change as well.
- **Water Quality issues:** After a fire, the loss of vegetation can lead to increased runoff and soil erosion, impacting water quality and aquatic ecosystems. Furthermore, Fires can affect water sources, leading to problems with water supply for both human and natural systems.
- **Long-Term Recovery and Regeneration:** Forest ecosystems have the capacity to regenerate after a fire, but the process can take years or even decades. Human efforts, such as reforestation and habitat restoration projects, may be necessary to accelerate the process of recovery.
- **Socio-economic impact:** Forest fires have negative impacts on the ecological and socio-economic aspects of the country. They destroy biodiversity, ecosystem services, livelihoods, and cultural heritage. They also increase the risk of soil erosion, landslides, and floods.

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### Forest Fires Hazard Mitigation in India

- **National Laws:** As per, sections 26 and 33 of the **Indian Forest Act of 1927** it is a criminal offense to burn or to allow a fire to remain burning in reserved and protected forests.
  - **Wildlife Protection Act 1972**: Section 30 of the Wild Life (Protection) Act of 1972 further prohibits setting fire in wildlife sanctuaries.
- **National Action Plan on Forest Fires 2018 (NAPFF):** It has been formulated to minimize forest fires from taking place by informing, enabling, and empowering forest fringe communities and maybe incentivizing them to work in tandem with the forest departments.
- **Forest Fire Prevention and Management (FFPM) Practices:** These Practices are used to prevent forest fire. The most common methods of prevention employed by forest departments in India include the **clearance of fire lines and conducting controlled burning to limit fuel loads**. Other methods may include **silvicultural practices such as selective thinning and planting fire-adapted tree species in fire-prone areas.** Telangana is the only state to have digitized locations of fire lines.
- **Forest Survey of India Initiatives:** FSI implemented its **first nationwide system for monitoring active forest fires using remote sensing and providing alerts to local forest departments in 2004.** State-level detection and alert systems have also been developed in states of Madhya Pradesh, Andhra Pradesh, Chhattisgarh, Telangana, and Uttarakhand.
  - The Forest Survey of India developed in 2016, an **indigenous "Early Warning Alert System for Forest Fire".** The alerts to State Forest departments are based on parameters like Forest Cover, Forest Type, and Climatic Variables (Temperature and Rainfall).
  - **Managing Drought:** Drought is an important factor in forest fires FSI has attempted to use **Keetch–Byram Drought Index (KDBI)** which is being tested in 25x25 sq. km grid in Dehradun, Uttarakhand. The KBDI can be used to forecast fire danger ten to twelve weeks in advance.
- **Large Forest Fire Monitoring Programme:** It uses near-real-time SNPP-VIIRS data to track large fire events across the country.
- **FAST 3.0 Collaboration:** The program receives NASA's active fire data, processed by ISRO, and then updated by FSI. The information is disseminated in real-time to over 40,000 registered users, including governmental and public entities, through the forest alert system.

| FAO Recommendations On Forest Fire | |
|---|---|
| **Preventive Programs** | Emphasise zoning, danger rating, early warning, and real-time monitoring to enhance forest fire prevention. |
| **Coordination** | Advocate collaboration with government agencies (e.g., National Remote Sensing Agency, Forest Survey of India, Meteorological Department) and media for coordinated actions during fire season. |
| **National Awareness Campaign** | Suggest the launch of a nationwide campaign on fire damage, prevention, detection, and communication involving schools, Joint Forest Management committees, NGOs, and voluntary organizations. |
| **Research and Training Institute** | Propose the establishment of a central fire management research and training institute to equip foresters and public agencies with knowledge and skills for effective fire management. |
| **Integration with Joint Forest Management** | Recommend incorporating prevention and management programs into the Joint Forest Management framework by state governments. |
| **Inclusion in National Forestry Action Plan** | Urge the specific designation of fire management as an element of "Protection" in the list of priority strategies within the National Forestry Action Plan. |



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### Case Study: Cool Burning Method in Australia

**Challenge:** Kakadu National Park, a UNESCO World Heritage Site renowned for its biodiversity and Indigenous cultural **significance, faces a significant threat from wildfires.** The park's vast savannas and woodlands experience hot, dry seasons that create ideal conditions for uncontrolled wildfires, potentially devastating the ecosystem and cultural heritage.

**Solution:** Traditional cool burning practices, **championed by Indigenous Australians for millennia,** are being revived and integrated with modern fire management strategies to protect Kakadu.

#### Implementation

Fig. 3.18

- **Mosaic Burning:** Burning small, controlled patches in a mosaic pattern throughout the park during cooler months. This creates firebreaks and reduces fuel load, hindering the spread of future wildfires.
- **Indigenous Knowledge:** Collaborating with traditional owners, the **Mirarr people,** to leverage their deep understanding of the land and fire behaviour. **Their insights guide burn location, timing, and intensity.**
- **Modern Technology:** Utilising **drones and satellite imagery** to monitor fire activity and fuel loads, ensuring precision and safety during controlled burns.
- **Community Engagement:** Educating park visitors and local communities about the benefits of cool burning and fostering collaboration in fire management efforts.

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### Challenges in Mitigation

- **Climate change and droughts:** Forests become more prone to fires due to prolonged droughts and rapid changes in climate and weather conditions, such as high temperatures, low precipitation, and strong winds. These factors are driving forest fires not only in India but also across the world.
- **Fragmentation of forests:** India's forests are mostly fragmented and surrounded by human settlements of various sizes, which increase their exposure and susceptibility to fires. Human activities, such as agriculture, grazing, and burning of biomass, are also major sources of ignition.
- **Inadequate resources:** Forest departments lack sufficient funds to invest in effective forest fire mitigation infrastructures, such as fire detection, suppression, and safety equipment. Instead, they spend a large amount of money on planting trees, which may not survive or adapt to the changing environment.
- **Insufficient personnel:** Forest departments also face a shortage of trained and equipped staff to respond to forest fire incidents.

### Way Forward

- **Community-based fire management:** Engaging local communities in fire prevention and early detection activities empowers them to become stewards of their own forests. Examples include **Firewise USA, Canada's FireSmart program and community forestry programs in Nepal.**
- **Advanced monitoring systems:** Utilizing remote sensing technology like satellites and drones for real-time fire detection allows for rapid response and minimizes fire spread. Countries like Spain and Portugal have successfully implemented such systems.
- **Rapid initial attack:** Responding quickly to small fires with trained personnel and appropriate equipment can prevent them from becoming larger and more difficult to control. Israel's rapid response teams and Indonesia's Manggala Agni fire fighting brigade exemplify this approach.
- **Effective fire suppression strategies:** Employing a combination of ground and aerial firefighting techniques adapted to the specific terrain and fuel types is crucial for successful fire suppression. Canada's air tanker fleet and China's emphasis on ground firefighting demonstrate different approaches.
- **Burned area rehabilitation:** Implementing measures like reforestation, erosion control, and wildlife habitat restoration promotes the recovery of ecosystems damaged by fires. The **US Forest Service's Burned Area Emergency Response Team (BAER) and Spain's post-fire recovery plans are commendable examples.**
- **Community engagement in recovery:** Involving local communities in post-fire rehabilitation efforts fosters ownership and ensures long-term success. Programs like Nepal's Community Based Forest Management (CBFM) and Indonesia's community-based fire management initiatives showcase this approach.
- **Knowledge sharing and capacity building:** Collaborating with other countries and organizations to share best practices, training personnel, and developing technologies is essential for continuous improvement in forest fire management. Initiatives like the Global Fire Monitoring Center (GFMC) and the International Association of Wildland Fire (IAWF) facilitate such cooperation.

## CONCLUSION

Throughout this chapter, we've delved into the complexities of natural disasters – their diverse forms, causes, risks, impacts and measures taken by the government to tackle them. While we cannot control the Earth's unpredictable nature, we have the power to shape our response. Mitigation strategies, from robust infrastructure to community preparedness, offer powerful tools to lessen the sting of disaster. Embracing these measures isn't just about safeguarding lives and property; it's about fostering resilient communities, capable of bouncing back stronger and adapting to a changing world.



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# Anthropogenic Disasters and Their Mitigation

4

## INTRODUCTION

Anthropogenic disasters, also known as human-caused disasters, are events resulting primarily from human actions or inactions that have significant negative consequences for human life, property, the environment, or a combination of these. The Chernobyl nuclear disaster (1986), The Bhopal gas tragedy (1984) are few of the examples.

## NUCLEAR EMERGENCIES

A nuclear emergency involves the explosion of a nuclear weapon or improvised nuclear device (IND). The explosion produces an intense pulse of heat, light, air pressure, and radiation. Nuclear explosions produce fallout (radioactive materials that can be carried long distances by the wind). The impact depends on factors like release amounts, wind dynamics, and weather conditions. Accidental radiation exposure can also happen during transportation or machinery failures in radiation facilities. Preparedness and response strategies are vital for addressing these complex nuclear disaster scenarios.

### Causes of Nuclear Emergencies

- **Reactor malfunctions:** Equipment failures, operator errors, or design flaws can lead to overheating and loss of control within the reactor core, which potentially causes a meltdown and release of radioactive materials. The **Chernobyl disaster in 1986** serves as a tragic example, where reactor design flaws and operator errors combined to cause a catastrophic explosion and widespread radioactive contamination.
- **Natural disasters**: Earthquakes, tsunamis, or other natural disasters can damage nuclear power plants and disrupt safety systems, increasing the risk of radioactive releases. The **Fukushima Daiichi nuclear disaster in 2011** occurred after a massive earthquake and tsunami triggered equipment failures and core meltdowns at the plant.
- **Transportation accidents:** Accidents involving vehicles carrying radioactive materials can lead to breaches in containment and release of radiation. A notable example occurred in **1987 in Goiânia, Brazil,** where a radioactive source was stolen from a medical facility and subsequently mishandled by individuals, leading to several deaths and widespread contamination.
- **Nuclear terrorism:** Terrorist groups may attempt to acquire and detonate nuclear devices, causing widespread radioactive contamination and human casualties. This remains a potential threat, although international efforts focus on preventing such scenarios.
- **Nuclear warfare:** The detonation of nuclear weapons in warfare would unleash catastrophic levels of radiation and lead to immense destruction. For instance **USA attack on Japan in 1945.**

### Risk of Nuclear Emergencies in India

- **Increasing Use of Nuclear Technology**: As per NDMA website, India has 20 power reactors and three research reactors in operation along with five power reactors under construction. It has also been planned to explore setting up Thorium based reactors to meet its ever increasing energy needs. The country is also at the verge of making operational the first 500MW prototype Fast Breeder Reactor (PFBR) after a prolonged experience of operation of FBTR (Fast Breeder Test Reactor). Further, the country utilizes radioisotopes in a variety of applications in the non-power sector, viz., in the field of industry, agriculture, medicine, research, etc.
- **Natural Disasters:** The December 2004 tsunamis, triggered by a magnitude 9 earthquake in Indonesia, reached the west coast of India and impacted the **Kalpakkam nuclear power plant** near Madras/Chennai. The Narora plant in Uttar Pradesh is located in Seismic Zone IV. Thus can be impacted by Earthquakes.
- **Terrorism and Sabotage:** Concerns persist regarding intentional terrorism targeting nuclear facilities or materials, encompassing risks from sabotage by external entities or insider threats to the security of nuclear installations. For example, **Stuxnet cyberattack,** a computer worm that specifically targeted **Iran's nuclear program, disrupted operations at its Natanz uranium enrichment facility.**
- **Inadequate Emergency Preparedness:** Insufficient readiness and response capabilities can worsen the consequences of a nuclear emergency.
- **Aging Infrastructure:** Challenges in safety and reliability stem from the ageing infrastructure of some nuclear facilities.
- **Waste Management Challenges:** Long-term challenges and environmental risks arising from safe disposal and management of nuclear waste.

### Impact of Nuclear Emergencies

Nuclear emergencies or disasters can happen due to human mistakes, natural disasters, or deliberate attacks. They can have serious effects on people, the environment, or the nuclear facility. Some of the possible effects are:

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- **Radiation exposure:** Nuclear accidents can release a lot of radioactive material into the air, water, or soil. This can harm people's health in different ways such as, causing radiation sickness, cancer, or changes in their genes, depending on how much and how long they are exposed to radiation. The worst nuclear accident ever was the **Chernobyl disaster in 1986, which killed 50 people from radiation and caused about 5000 cases of thyroid cancer**. The Fukushima nuclear disaster in 2011, which was caused by a huge earthquake and tsunami, did not kill anyone from radiation but made more than 100,000 people had to leave their homes.
- **Environmental contamination:** Nuclear accidents can also affect the environment by making the land, water, or food sources radioactive. This can have lasting effects on the environment and the economy, such as reducing the variety of living things, damaging the soil, or making the crops less productive. For example, after the **Chernobyl accident, a 30-km area around the plant was made off-limits to people and there was a significant change in the fauna also.** Another such instance is the Fukushima accident where some of the places have become too radioactive to live in and some food products were declared not safe to consume.
- **Psychological and social effects:** Nuclear accidents can also affect people's feelings and relationships, such as making them scared, worried, stressed, sad, or ashamed. These effects can be caused by the lack of information, wrong information, or being alone due to nuclear emergency. They can also affect people's mental and physical health, happiness, and sense of belonging. For instance, After the **Fukushima accident, many people felt sad, lonely, or discriminated against.**

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## Steps Taken by the Government

- **Improved Technology:** Newer reactors in India are equipped with built-in safety measures that are designed to minimize risks. For example, new light water and heavy water reactors at nuclear plants such as Tarapur nuclear power plant in the state of Maharashtra and the Kudankulam Nuclear Power Plant in Tamil Nadu have **double containment to ensure that nuclear material is confined in case of a nuclear emergency.'**
  - In Tarapur 3 an indigenously developed **containment filtered venting system**, which operates on the wet-scrubbing principle, has been operational for some time and is set to see fleet-wide deployment.
  - NPCIL is also **deploying iodine scrubbing** through a containment spray system on which tests using different aerosols have been conducted and removal rate measurements recorded. Even the Tarapur 1&2 BWRs, which are older than Fukushima Daiichi I and had been upgraded prior to 2011 to ensure continuous cooling during site blackouts, were modified in the last decade to allow nitrogen injection into the containment in the event of a hydrogen build-up.
- **Atomic Energy Act, 1962:** An Act to provide for the development, control and use of atomic energy for the welfare of the people of India and for other peaceful purposes and for matters connected there with.
- **The Civil Liability for Nuclear Damage Act of 2010 (CLND Act):** It is pivotal in addressing the civil liability associated with nuclear damage. This legislation establishes a legal structure for compensation in the event of a nuclear incident, aligning India with international conventions on nuclear liability.
- **The National Disaster Management Act of 2005:** Though not explicitly tailored for nuclear emergencies, it lays down the legal groundwork for disaster management in the country. In the context of a nuclear incident, the National Disaster Management Authority (NDMA) assumes a crucial role in orchestrating and executing disaster response and recovery initiatives.
- **The Radiological Emergency Preparedness and Response Plan (REP&R):** It was developed by the Atomic Energy Regulatory Board (AERB). It delineates strategies and actions to be implemented in the event of a radiological emergency, encompassing scenarios related to nuclear power plants.
- **Department of Atomic Energy (DAE):** It is designated as the nodal agency for man-made radiological emergencies in the public domain. Activates the Crisis Management Group (CMG) promptly in case of nuclear/radiological emergencies. Ensures coordinated technical responses in collaboration with local and central authorities.
- **Atomic Energy Regulatory Board:** It functions as the nuclear regulatory authority in India. Mandated by the Atomic Energy Act, of 1962, to issue licenses for nuclear and radiation facilities. It develops safety policies, codes, guides, and standards for all phases of facility life cycles and reviews emergency preparedness plans and oversees training programs for personnel in nuclear and radiological facilities. Along with this it takes steps to inform the public about significant radiological safety issues.
- **Mobile Radiation Detection System (MRDS):** To detect unclaimed radioactive materials/substances and save the public from its hazardous effects, NDMA has chalked out a plan to provide States/UTs **Mobile Radiation Detection Systems** to be deployed in Metros/all Capital Cities and Big Cities in India.

### Challenges in Mitigation of Nuclear Emergencies in India

- **Limited monitoring and early warning systems:** Expanding the network of radiation monitoring stations across the country, especially in populated areas near nuclear facilities, would ensure faster detection and response.



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- **Upgrade of emergency response equipment and medical facilities:** Equipping first responders with specialized protective gear and ensuring adequate stockpiles of radiation decontamination materials is crucial. Additionally, medical facilities require dedicated resources and trained personnel to handle cases of radiation exposure. Greenpeace released a report(2016) **'Red Alert – India's nuclear disaster plans outdated and inadequate', highlighted key issues like "lack" of emergency preparedness, "ancient" manual for emergency guidelines, "unacceptable" standards of food contamination among the reasons for India's plans being "outdated" in case of an emergency.**
- **Lack Implementation:** The Greenpeace report also stated that The manual on emergency preparedness at Kalpakkam, despite being revised in April 2011, still includes a regulatory guideline with intervention levels based on Publication 40 of the International Commission on Radiological Protection (ICRP) adopted in 1984 which was well before the Chernobyl disaster.

## Way Forward

To address these challenges, India needs to adopt a holistic and proactive approach to nuclear emergency management, which includes:

- **Enhancing the prevention and mitigation measures**, such as improving the design, construction, and operation of the nuclear power plants, conducting regular safety audits and inspections, and implementing stringent security protocols.
- **Strengthening the preparedness and response capabilities**, such as developing and updating the emergency plans and procedures, conducting realistic and effective drills and exercises, and providing adequate training and equipment to the emergency personnel.
- **Improving the public information and participation mechanisms**, such as increasing the transparency and accountability of the nuclear authorities, disseminating accurate and timely information to the public, and engaging the local communities and civil society organizations in the nuclear emergency management process.
- **Harmonizing national and international cooperation and coordination**, such as establishing a clear and consistent legal and regulatory framework, participating in the global nuclear safety and security regimes, and seeking technical and financial assistance from the international community.
- Conducting mock drills to review the emergency preparedness plan of the organization and enable the public at times of need.

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### NDMA Guidelines

| NDMA Guidelines for Nuclear and Radiological Emergencies | |
|---|---|
| **Enhanced Monitoring and Warning Network** | ❑ Enhance radiation monitoring for swift detection of nuclear facility emissions, weapons activities, and transportation of nuclear materials. |
| **Prevention of Illicit Movement** | ❑ Implement a monitoring system with radiation detectors at border posts and ports to prevent illegal transportation of radioisotopes. |
| **Robust Communication Networks** | ❑ Establish a reliable and dedicated national-level communication network to ensure effective last-mile connectivity. |
| **Dissemination of Warnings and Information** | ❑ Ensure widespread warnings reach remote, rural, and urban areas for an organised response; regularly update the information to combat misinformation and prevent panic. |
| **Implementation of Structural Measures** | ❑ Identify secure buildings and sites for temporary shelters in proximity to nuclear installations.<br>❑ Construct versatile shelters near nuclear installations, adhering to relevant building codes. |
| **Comprehensive Medical Management Plan** | ❑ Establish specialised tertiary care hospitals for radiation injuries.<br>❑ Deploy primary and secondary care facilities in key cities to ease the healthcare infrastructure burden. |

# MINE DISASTERS

The **Mines Act 1952 defines disasters in terms of accidents causing the loss of more than 10 lives.** In the context of mining, a mining accident is an unexpected event that occurs during the process of extracting minerals. The Act categorizes accidents involving the loss of fewer than 10 lives as major accidents. One of the most significant mining disasters in Indian history took place on December 27, 1975, at Chasnalla Colliery.

## Causes of Mine Disaster

- **Ground instability:** Collapses, rockbursts, and sinkholes can occur due to natural factors like weak geological formations, seismic activity, or water infiltration. The **2010 Upper Big Branch disaster** in the US, resulting in 29 fatalities, was caused by a methane explosion triggered by a mining machine.
- **Gas explosions:** Flammable gases like methane and coal dust can accumulate in enclosed mine spaces, igniting and causing powerful explosions.



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- **Flooding:** Sudden inrushes of water from underground sources or heavy rainfall can flood mines, trapping miners and causing structural damage. The flooding incident in the **Bagdigi colliery in Jharkhand in 2001** resulted in the deaths of several miners.
- **Equipment malfunction:** Faulty machinery, electrical systems, or ventilation equipment can create dangerous conditions like fires, gas leaks, or oxygen depletion. For example **West Virginia Sago Mine disaster 2006 where 12 miners died due to a roof collapse caused by a faulty belt conveyor.**
- **Structural instability:** Improperly designed or maintained mine supports, tunnels, or shafts can collapse under pressure.
- **Transportation accidents:** Malfunctioning trains, trolleys, or other transportation systems within mines can cause injuries and fatalities.
- **Unsafe working practices:** Failure to follow safety protocols, improper use of equipment, or ignoring warning signs can increase the risk of accidents.
  - **Inadequate training and supervision:** Untrained or inexperienced workers who lack proper safety knowledge and procedures are more vulnerable to accidents.
  - **Negligence and cost-cutting measures:** Prioritizing production over safety standards, disregarding maintenance needs, or using poor-quality materials can significantly increase the risk of disasters.

## Risk of Mine Disasters in India

- **Outdated mining methods:** Many Indian mines continue to utilize outdated and inherently risky mining techniques, increasing the likelihood of accidents and collapses. For example **Rat-hole mining** which is prevalent in **Meghalaya** involves extracting coal through small pits known as "rat holes," using manual tools.
- **Inadequate safety measures:** Stringent safety protocols and implementation are often lacking, leading to unsafe working conditions and exposure to hazards. The **2016 Khetri copper mine collapse, claiming 12 lives,** involved the failure of an old winding shaft mechanism.
- **Negligence and disregard for regulations:** Instances of ignoring safety regulations or cutting corners to maximize profits add to the danger factor.
- **Lack of awareness and training:** Limited access to proper training and safety awareness programs can leave miners vulnerable to risks they may not fully understand.
- **Unstable geological formations:** Many Indian mines are located in seismically active zones or have structurally weak terrains, posing a high risk of ground instability and collapses.
- **Presence of natural hazards:** Heavy rainfall and water inrushes are common concerns in certain regions, increasing the risk of flooding and other dangers.
- **Poverty and desperation**: Miners, especially in small-scale or illegal operations, often work under pressure to meet financial needs, potentially compromising safety practices.
- **Inadequate enforcement and monitoring:** Weak enforcement of safety regulations and limited resources for regular mine inspections further exacerbate the problem.
- **Coal mines:** Methane explosions and coal dust explosions pose a significant threat in India's coal mines, contributing to a history of tragic accidents.
- **Metal and mineral mines:** Collapses and exposure to toxic gases are major concerns in these mines, highlighting the need for specific safety protocols based on the mined material.

### Rat-Hole Mining

Rat-hole mining which is prevalent in Meghalaya involves **extracting coal through small pits known as "rat holes," using manual tools.** Two methods, side-cutting and box-cutting, are employed to access thin coal seams in hill slopes. Safety and environmental concerns arise due to the lack of regulations, leading to unsafe working conditions and ecological damage. **The National Green Tribunal (NGT) banned rat-hole mining in 2014**, citing its unscientific nature. However, the practice persists due to economic factors and lack of alternative livelihoods.

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## Impact of Mine Disasters

- **Environmental Damage:** Mining disasters can lead to significant environmental damage, including the production of waste, the release of toxic and hazardous waste, air pollution, and emissions. It can also increase the acidity of water in streams, and cause increased sediment loads, some of which may be metal-laden, in drainage basins.
- **Water Pollution and Depletion:** Mining disasters can cause water pollution and depletion. For instance, debris flow and ground subsidence can damage water resources in the mining area, including pollution of water resources and blocked transportation routes of water resources.
- **Loss of Productive Land and Ecosystems:** Mining hazards can lead to the loss of productive land and ecosystems. Landslides, settlement and debris flows can cause serious damages to buildings and natural vegetation in the mining area.
- **Human Casualties:** Mining is deadly and thousands of miners die from mining accidents each year, especially from underground coal mining.
- **Long-term Impact:** The impact of mining disasters can be long-term and far-reaching. For example, the rupture



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of Samarco's mining company tailings dam in Mariana, Brazil, resulted in mud tailings that killed people and animals, destroyed cities, and affected marine life.

- **Socio-economic Impacts:** Mining disasters can have socio-economic impacts, affecting livelihoods and leading to displacement and social upheaval.

## Steps Taken by the Indian Government

- **Mines Act 1952:** This primary legislation covers all aspects of mine safety, including safety standards, equipment specifications, training requirements, and accident reporting procedures.
- **Metalliferous Mines Regulations 1961 and Coal Mines Regulations 2011:**These detailed regulations prescribe specific safety protocols for different types of mining activities.
- **Directorate General of Mines Safety (DGMS):** This Central Government agency is responsible for enforcing mining regulations, conducting inspections, investigating accidents, and promoting safe mining practices.

### Safety Policy of Coal India Limited (CIL)

Coal India Limited's Safety Policy underscores a steadfast dedication to prioritising safety in mining operations through comprehensive measures, regulatory compliance, and a pervasive safety culture across all organizational levels.

- **Planning for Hazard Elimination:** Operations and systems are designed to eliminate mining hazards, with a focus on ensuring the safety of personnel and equipment.
- **Compliance with Statutory Rules and Regulations:** CIL emphasizes strict adherence to statutory rules and regulations related to safety, and it commits to achieving superior safety standards..
- **Joint Consultations on Safety Matters:** The organization establishes forums for joint consultations with employees' representatives to discuss safety matters. It aims to secure the motivation and commitment of employees in safety management.
- **Annual and Long-Term Safety Plans:** The formulation of annual safety plans and long-term safety plans is emphasized. These plans are designed to address specific geological and mining needs, ensuring preparedness for challenges such as monsoons.
- **Framework for Execution:** CIL sets up a framework for the execution of the Safety Policy and Plans through the involvement of General Managers, Area Safety Officers, Agents, Managers, and other safety personnel at the mines.
- **Multi-level Monitoring:** The implementation of Safety Plans is closely monitored at various levels, including the company headquarters and area levels. Internal safety organisations are responsible for overseeing and assessing safety measures.
- **Safety Consciousness at all Levels:** Senior executives and management at all levels are encouraged to inculcate safety consciousness in their functioning. The goal is to develop a strong commitment to safety practices and accident prevention.
- **Continuous Education and Training:** Continuous education, training, and retraining programmes are instituted for all employees, emphasising the development of safety-oriented skills. This ongoing learning is crucial for maintaining a high level of safety awareness.

## Challenges in Mining Disaster Risk Reduction in India

- **Poor understanding of disaster causes:** The root causes of mine disasters are not fully understood, which makes it difficult to prevent or predict them.
- **Ineffective engineering controls:** The existing engineering controls are not sufficient to prevent, detect, or mitigate Mine disasters.
- **Lack of workforce training:** The general mining workforce lacks adequate education and training on how to deal with Mine emergencies.
- **Inefficient forecasting and mitigation**: Forecasting and mitigating mine disasters, whether natural or manmade, is a major problem.
- **Vulnerable infrastructures:** Critical infrastructures such as power, communication, water, and transport are exposed to disaster risks.
- **Limited funding:** Preparedness and mitigation measures are often neglected due to the priority given to relief as a disaster response.
- **Non-standardized efforts:** There is no standardization in collecting and analyzing geo-spatial data, satellite imagery, and early warning signals.
- **Weak areas:** Forecasting, modeling, risk prediction, simulation and scenario analysis, etc.
- **Poor implementation:** The National Disaster Management Plan, and the State and district level disaster management plans are not implemented properly.

## Way Forward

- **Modernize equipment:** Replacing outdated machinery with modern, well-maintained technology can significantly reduce equipment failure risks. The **US Mine Safety and Health Administration (MSHA)** promotes using safer technologies like methane monitors and automated roof bolting equipment.
- **Invest in advanced monitoring systems:** Implementing real-time monitoring systems for gas levels, air quality, and ground stability can provide early warnings of potential dangers. Australia's **MineSAFE system** and **Chile's Strata Control Unit (SCU) offer valuable examples.**
- **Improve ventilation and drainage systems:** Upgrading ventilation systems and ensuring proper drainage infrastructure prevent harmful gas buildup and water

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inundation. China's focus on advanced ventilation systems in coal mines showcases effective practices.

- **Strengthen safety regulations:** Regularly reviewing and updating mining regulations to address emerging risks and best practices is crucial. **The UK's Health and Safety Executive (HSE)** constantly revises its mining regulations based on evolving risks and research.
- **Improve inspection and enforcement mechanisms:** Ensure thorough and regular inspections by adequately trained and equipped personnel. **Canada's Coal Mine Health and Safety Law has robust enforcement mechanisms** with significant penalties for non-compliance.
- **Promote transparency and accountability:** Encourage whistleblower protections and public reporting of safety concerns to empower miners and stakeholders to demand accountability. The **US MSHA's anonymous complaint system exemplifies this approach.**
- **Provide comprehensive safety training:** Equip miners with thorough training on safety protocols, emergency procedures, and hazard identification. **Finland's mandatory safety training programs** for all miners set a high standard.
- **Involve communities and stakeholders:** Engage local communities and NGOs in safety discussions and initiatives to build trust and ensure collaborative efforts. **South Africa's Mine Health and Safety Act** actively involves unions and communities in safety decision-making.
- **Invest in research on safer mining practices:** Support research into safer mining technologies, materials, and risk assessment methods. The **European Union's Horizon 2020 program funded several projects on mine safety innovations.**

# INDUSTRIAL AND CHEMICAL DISASTERS

Industrial and Chemical Disasters refer to catastrophic incidents that occur as a result of mishaps, accidents, or failures in industrial processes involving hazardous chemicals. These disasters can result from failures in processes, human errors, technical issues, management lapses, natural calamities, transportation accidents, and even terrorist attacks.

## Causes of Industrial and Chemical Disasters

- **Human Errors:** These are errors made by workers due to mistakes, lack of training, or negligence. For example In **Buncefield Oil Depot Explosion (2005)** Hertfordshire, UK, a worker at the oil depot mistakenly transferred gasoline into a storage tank containing incompatible chemicals, triggering a series of explosions and fires
- **Technical Errors:** It is caused by mechanical failures, software defects, or deviations from normal operational conditions. **Visakhapatnam Gas Leak (2023)** involved a leak of styrene gas from the LG Polymers chemical plant in Andhra Pradesh. While the exact cause is still under investigation, initial reports suggest a malfunction in the refrigeration system used to store the highly flammable liquid.
- **Management Errors:** It is a result of poor planning, lack of safety measures, or inadequate supervision. For instance **Bhopal Gas Tragedy (1984)** was attributed to a series of human errors, including faulty maintenance, inadequate safety procedures and poor emergency response.
- **Unsafe Conditions:** These are conditions that pose a risk to the workers, the equipment, or the environment. For example **Neyveli Lignite Corporation boiler explosion (2020)** was attributed to faulty boiler maintenance and inadequate safety protocols.
- **Component Failures:** These are failures of machinery or equipment components that can lead to accidents. For example, a component may break down, wear out, or malfunction.
- **Natural causes:** These are disasters caused by natural events such as earthquakes, floods, or storms. **Fukushima Nuclear Power Plant Accident (2011)** was primarily triggered by a massive earthquake and tsunami.

## Risk of Industrial and Chemical Disaster in India

- **Unorganized Sector:** There are around 1,861 Major Accident Hazard (MAH) units in India, which handle hazardous chemicals. Besides, there are many more unsafe factories and informal sector units that pose a risk of disaster.
- **Aging Infrastructure and Design Flaws:** Many chemical plants in India are old, faulty, or have not been modernized, making them prone to accidents.
- **Increasing Frequency:** As per National Disaster Management Authority (NDMA) In the last decade, 130 significant chemical accidents were reported in India, which resulted in 259 deaths and 563 major injuries.
- **Human Error:** A significant amount of industrial accidents happen because of human errors, such as violating the Standard Operating Procedures (SOPs).
- **Organic Solvents:** Solvents are one of the main causes of fires and explosions in the chemical industry.
- **Terrorist Activities and Sabotages:** It poses another source of threat, as they could target chemical plants or transport vehicles.

## Impact of Industrial and Chemical Disasters

- **Human Health: Bhopal Gas Tragedy (1984)** Impacted over 5 lakh people and resulted in over 3,800 deaths,



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numerous injuries, and long-term health issues due to exposure to hazardous substances like Methyl isocyanate. As per a **2015 International Labour Organization** report Globally, occupational accidents contribute to over **350,000 deaths yearly, causing 313 million serious injuries and work absences.**

- **Natural Environment:** Chemical spills or leaks have a far-reaching impact on the natural environment, contamination of air, soil, water, and living organisms. This can result in ecological degradation, damaging essential ecosystem services, and diminishing overall resilience. The effective cleanup and restoration required also demands considerable time and financial resources. **Bhaghjan Gas and Oil Leak (2020)** resulted in environmental damage to Dibru-Saikhowa National Park and Maguri-Motapung Wetland.
- **Economy:** Industrial and chemical disasters leave a profound impact on the economy, disrupting the production, transportation, and supply chain. These disruptions result in substantial economic losses, affecting income, employment rates, and market share for the industries involved. Legal liabilities, compensation claims, and reputational damage further increase the economic fallout. The government may also find itself compelled to allocate substantial funds for relief, rehabilitation, and recovery efforts among affected communities and regions.

## Steps Taken by the Government

- **Regulatory measures:** The relevant provisions on chemical disaster management, prevailing in the country are **Explosives Act 1884, Petroleum Act 1934, Factories Act 1948, Insecticides Act 1968, Environment Protection Act 1986,Motor Vehicles Act 1988, Public Liability Insurance Act 1991 and Disaster Management Act 2005.**
- **Legal Mechanism:** Government of India has further reinforced the legal framework on chemical safety and management of chemical accidents by enacting new rules such as Manufacture, Storage and Import of Hazardous Substances Rules, 1989, The Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules, 1996, SMPV Rules, Central Motor Vehicles Rules, Gas Cylinder Rules, Hazardous Waste Rules, Dock Workers Rules and by way of amendments to them.
- **Enforcement Mechanisms:** The Ministry of Labour and Employment, in collaboration with the Directorate General Factory Advice Service and Labour Institutes, enforces hazardous processes under the Factories Act, 1948.
- **NDMA initiatives:** Apart from **specific guidelines on Chemical Disaster Management,** NDMA is also working on revamping of CIFs (Chief Inspectorate of Factories) to strengthen chemical safety in India. In addition, the National Action Plan on Chemical Industrial Disaster Management (NAP-CIDM), has been finalized which will act as the roadmap for chemical disaster management in India.

### Oleum Gas Leak

The **M.C. Mehta vs. Union of India (1986)** case, also known as the **Oleum gas leakage** case, was filed by environmental activist and lawyer M.C. Mehta against Shriram Foods and Fertilizers Industries for manufacturing hazardous substances in a densely populated area. The case is related to an oleum gas leak from the industry which resulted in death and health issues for many. This landmark case significantly altered the application of environmental laws in India and the interpretation of Articles 21 and 32 of the Indian Constitution, dealing with the right to life and remedies for fundamental rights violations respectively. The judgment explored legal issues and introduced new legal principles. The case challenged the then-prevalent 'strict liability' principle, which held companies accountable only if proven negligent. However, proving negligence in complex industrial accidents was often difficult and time-consuming. The court established the principle of absolute liability, stating that any enterprise engaged in hazardous or inherently dangerous activities is strictly liable for any harm caused by such activities, irrespective of negligence. This meant that the burden of proof shifted from the victim to the company, making it responsible for preventing damage and compensating those affected.

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## Challenges in Industrial and Chemical Disaster Mitigation in India

- **Enforcement of Regulations:** India has a complex web of safety regulations, but inconsistent enforcement and loopholes weaken their effectiveness. Additionally, the capacity for safety inspections and audit often falls short of requirements.
- **Inadequate Worker Training and Safety Culture:** Insufficient safety training leaves workers vulnerable and unprepared for emergencies. A culture prioritizing production over safety further exacerbates the risk.
- **Management of Hazardous Chemicals (HAZCHEM):** Handling large quantities of HAZCHEM in installations, isolated storages, and during transportation, poses the grave risk of a sudden release of copious quantities of toxicants in the environment.
- **Industrial Locations:** Many industries that store or process large quantities of chemicals are situated in



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densely populated areas, increasing the risk of exposure to these substances.

- **Awareness and Preparedness:** The vulnerability is further increased due to inappropriate construction practices and lack of awareness and preparedness.

## Way Forward

- **Safer engineering and operational practices**: Chemical manufacture, use, storage, and transportation should follow the best engineering and operational safety standards to prevent accidents and minimize risks.
- **Intelligence and surveillance**: The movement of hazardous chemicals and the potential threats of chemical terrorism should be monitored and reported by the relevant authorities and agencies.
- **Emergency planning and preparedness**: On-site and off-site emergency plans should be developed and rehearsed, and community awareness should be generated of the possible hazards and the response procedures. Resource and risk inventory and capacity building for disaster management should also be conducted regularly.
- **Response capabilities**: Rescue and emergency medical resources should be available and accessible in case of a chemical disaster. Environmental monitoring, decontamination, and rehabilitation should also be carried out to minimize the impact and restore normalcy.
- **Legal safeguards and regulations**: The existing laws and rules against chemical disasters in India, such as the Bhopal Gas Leak (Processing of Claims) Act, 1985, the Environment Protection Act, 1986, the Public Liability Insurance Act, 1991, the Chemical Accidents (Emergency, Planning, Preparedness, and Response) Rules, 1996, and the National Green Tribunal, 2010, should be enforced and complied with by all the stakeholders.
- **International and national recommendations**: The recommendations of the International Labour Organization (ILO) and the National Disaster Management Authority (NDMA) on industrial disaster prevention, preparedness, and mitigation should be followed and implemented by the relevant authorities and industries.

### NDMA Guidelines on Chemical and Industrial Disasters

- **Codes of Practices, Procedures, and Standards:** Develop and implement codes of practices, procedures, and standards that detail the safe handling, storage, and disposal of hazardous chemicals. This helps create a uniform and safe approach to chemical management.
- **Statutory Inspection, Safety Auditing, and Testing of Emergency Plans:** Regular inspections, safety audits, and testing of emergency plans are crucial. This ensures that facilities are in compliance with safety regulations, emergency response plans are effective, and necessary precautions are taken.
- **Technical and Technological Information:** Providing access to technical and technological information equips relevant stakeholders with the latest knowledge about chemical substances, their properties, and advancements in handling them safely.
- **Education and Training:** Education and training programmes are essential for individuals involved in chemical disaster management. This includes training on handling emergencies, using safety equipment, and understanding the nature of different chemicals.
- **Creation of Appropriate Infrastructure:** Developing infrastructure, such as emergency response centres, chemical storage facilities, and communication networks, ensures that the necessary resources are in place to respond effectively to chemical disasters.
- **Institutional Framework:** Establishing a robust institutional framework involves creating organizations, committees, and authorities dedicated to chemical disaster management, ensuring a coordinated and effective response.
- **Networking and Information:** Facilitating networking and information exchange among relevant agencies, industries, and emergency responders helps in sharing best practices, lessons learned, and staying updated on emerging trends.
- **Medical Preparedness:** Ensuring medical preparedness involves having adequate healthcare facilities, medical personnel, and resources to address health-related issues arising from chemical disasters, including injuries, poisoning, and long-term health effects.
- **Research and Development:** Investing in R&D for chemical disaster management involves exploring new technologies, materials, and strategies to improve the overall preparedness and response to chemical incidents.
- **Emergency Medical Response:** Developing and implementing emergency medical response plans ensures that immediate medical care is provided to those affected by chemical disasters.
- **Preparation of On-Site and Off-Site Emergency Plans:** This step focuses on developing comprehensive emergency plans that cover both on-site and off-site scenarios. On-site plans address immediate actions within the facility, while off-site plans consider the broader impact and responses needed in the surrounding areas.

## ROAD ACCIDENTS

Road accident management in India involves prompt emergency response, coordinated efforts among police and medical services, and ongoing initiatives for public awareness,



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infrastructure improvement, and legal enforcement to enhance road safety and reduce casualties.

### Data-Wise

- According to the Road Accidents in India-2022 report, there were 4,61,312 reported road accidents, causing 1,68,491 fatalities and 4,43,366 injuries—an 11.9% increase in accidents, 9.4% in fatalities, and 15.3% in injuries compared to the previous year.
- Notably, 32.9% of accidents occurred on National Highways, 23.1% on State Highways, and 43.9% on other roads.
- Rural areas accounted for 68% of road accident deaths, with Tamil Nadu leading in accidents (13.9%) and Uttar Pradesh topping in fatalities (13.4%).

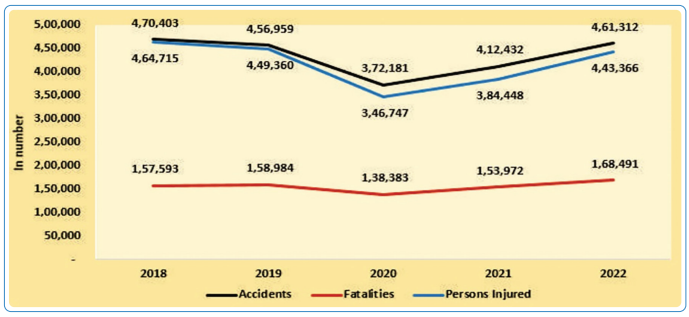


**Fig. 4.1:** Trends In The Number of Accidents and Fatalities 2018-2022

## Causes of Road Accidents

- **Human Error and Traffic Rule Violations:** The Ministry of Road Transport and Highways' annual report of accidents during **2022, revealed that 'overspeeding' accounted for 72.3 % of the total road accident 71.2 % of total deaths and 72.8 % of total injuries.**
- **Non-use of Safety Devices (Helmets and Seatbelts):** The report titled **'Road accidents in India — 2021'** of Ministry of Road Transport and Highways (MoRTH) said a total of **46,593 persons were killed in road accidents due to not wearing helmet, of which 32,877 were drivers and 13,716 were passengers.**
- **Accidents by Neighbourhood and Road Environment:** The majority of accidents (46.9%) occurred in open areas, followed by residential (18.6%) and market/commercial areas (14%). Institutional areas showed lower accident rates than expected, possibly due to better traffic rule enforcement.
- **Accidents by Road Features:** Accidents on straight roads accounted for 65%, while curved roads, potholes, and steep grades contributed to 15.2%.
- **Accidents by Road Junction Type:** "T Junction" had the highest share of accidents, deaths, and injuries. **Uncontrolled junctions accounted for the highest number of accidents (17.7%).**
- **Accidents by Weather Condition:** Most accidents occurred in sunny/clear weather (72%), while adverse conditions like rain, fog, and hail/sleet contributed to 18.4% of total road accident in 2020.
- **Accidents by Vehicular Condition:** Vehicles below 10 years of age accounted for over 58% of accidents and 56% of deaths. Overloaded vehicles constituted 6.7% of accidents, 7.9% of deaths, and 7.2% of injuries.

## Risks Associated with Road Accidents in India

- **Loss of life and productivity**: Road accidents are one of the leading causes of death among people aged 15 to 49 years. It further degrades the human capital as people lose their lives or suffer from disabilities due to road accidents.
- **Burden on the health care system**: Road accidents result in high demand for emergency and trauma care services, which strains the already overburdened health care system in India. Many road accident victims do not receive timely and adequate medical attention, which worsens their outcomes and increases the risk of complications and infections.
- **Damage to property and environment:** Road accidents also cause damage to vehicles, infrastructure, and the environment. The cost of repairing or replacing damaged vehicles and infrastructure is borne by the government, insurance companies, and individuals. Road accidents also contribute to air pollution, noise pollution, and greenhouse gas emissions, which harm the environment and public health.
- **Legal and social issues:** Road accidents often lead to legal disputes and litigation, which consumes time and resources of the victims, the perpetrators, and the judiciary. Road accidents also affect the social and psychological well-being as well.

## Impact of Road Accidents

**Road Accidents have A Profound and Far-Reaching Impact, Affecting Individuals, Families, and Communities Some of Them are as Follows:**

- Road accidents can cause physical injuries, emotional trauma, and loss of life for the victims and their families.
- Road accidents can also result in financial burden, disability and reduced mobility, and impact on mental health for the survivors and their caregivers.
- Road accidents can affect the quality of life and confidence of the victims, leading to chronic pain, isolation, and social problems.
- Road accidents can have a social and economic impact on communities and nations, causing losses in productivity, health care costs, and environmental damage.

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- Road accidents can be prevented by addressing the contributing factors such as speeding, reckless driving, drunken driving, and non-compliance with traffic regulations. It is important to improve the enforcement mechanisms, driver education, and training programs, and the condition of roads and vehicles.

## Steps Taken by the Government

Mitigating road accidents is imperative as revealed by the 'Road accidents in India -2022' report, citing a staggering 4,61,312 incidents in that year alone, resulting in 1,68,491 lives lost and 4,43,366 individuals injured. Addressing this alarming toll requires concerted efforts through enhanced safety measures, public awareness, and effective traffic management strategies.

### Road Accident Mitigation Measures Taken By MoRTH

The Ministry of Road Transport & Highways in India has implemented a comprehensive strategy to address road safety issues. Some key initiatives and measures they have taken:

- **The Motor Vehicles Act (Amendment) 2019:** Stricter penalties for offences, including speeding, dangerous driving, drunk driving, not wearing helmets, and use of mobile phones. Implementation of IT-enabled enforcement equipment and mandatory automated testing for fitness certification.
- **Protection of Good Samaritans:** Section 134A of the Motor Vehicles (Amendment) Act, 2019 safeguards Good Samaritans by allowing them not to disclose personal details unless voluntarily chosen, complemented by a Scheme for Award to Good Samaritans recognizing those who save lives by offering immediate assistance to accident victims.
- **Road Engineering:** Identification and rectification of accident blackspots on National Highways. Measures such as flyovers, underpasses, foot overbridges, and service roads are provided for long-term rectification.
- **Pedestrian Facilities:** Financial power delegated to regional officers for the construction of pedestrian underpasses, pedestrian subways, and foot overbridges.
- **Accredited Driver Training Centre:** Requirements for accredited driver training centres have been mandated, equipped with simulators and dedicated driving test tracks.

**IGNITE YOUR MIND**

Cars dominate our roads, creating congestion, pollution, and safety hazards. But what if we transform streets into dynamic spaces shared equitably by pedestrians, cyclists, and vehicles?

- **Institutes of Driving Training and Research (IDTR):** Setting up model IDTR centres, regional driving training centres, and driving training centres to improve driving skills and knowledge of road regulations.
- **Electronic Monitoring and Enforcement:** Rules have been notified for electronic monitoring and enforcement of road safety through various technologies.
- **Incident Management System:** Deployment of services like ambulances, patrol vehicles, and cranes at toll plazas.
- **National Road Safety Board (NRSB):** Establishment of NRSB to render advice on road safety and traffic management.

## Challenges of Mitigation of Road Accidents in India

- **Poor road design and engineering**, which do not take into account the safety of all road users, especially two-wheeler riders and pedestrians.
- **Lack of enforcement** of traffic rules and regulations, such as speed limits, helmet and seat belt use, drunk driving, and vehicle fitness.
- **Inadequate road safety education and awareness** among drivers, passengers, and the general public.

## Way Forward

- Enforce the **Motor Vehicles (Amendment) Act, 2019**, which has new provisions for road safety, such as higher penalties for traffic violations and mandatory insurance for road accident victims.
- Formulate and implement a **National Road Safety Policy and Action Plan**, which defines the roles and responsibilities of various stakeholders and sets targets and indicators for road safety performance.
- Carry out **road safety audits** and upgrade the quality and maintenance of road infrastructure, such as signage, markings, lighting, and crash barriers, to ensure the safety of all road users.
- Encourage the use of **safer and greener vehicles**, such as electric, hydrogen-powered, or hybrid vehicles, and ensure compliance with emission and safety standards, to reduce the environmental and health impacts of road transport.
- Strengthen the **capacity and coordination** of road safety agencies, such as the National Road Safety Board, the State Road Safety Councils, and the District Road Safety

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Committees, to oversee and monitor the road safety activities and initiatives.

- Improve the **data collection and analysis** of road accidents, using the revised format that includes new items on causes and factors, to identify the key risk factors and trends of road accidents and fatalities.
- Enhance the **insurance coverage and quality of emergency and trauma care** services for road accident victims, to provide timely and adequate medical assistance and compensation.
- Increase the **road safety education and awareness** campaigns, especially among vulnerable groups such as children, women, and senior citizens, to raise the road safety culture and behavior of the public.

## RAIL ACCIDENTS

Railway Disaster is a serious train accident and/or an untoward event of grave nature, either on railway premises or arising out of railway activity, due to natural or man-made causes, that may lead to loss of many lives and/or grievous injuries to a large number of people, and/or severe disruption of traffic etc, necessitating large scale help from other Government/ Non-government and Private Organizations.

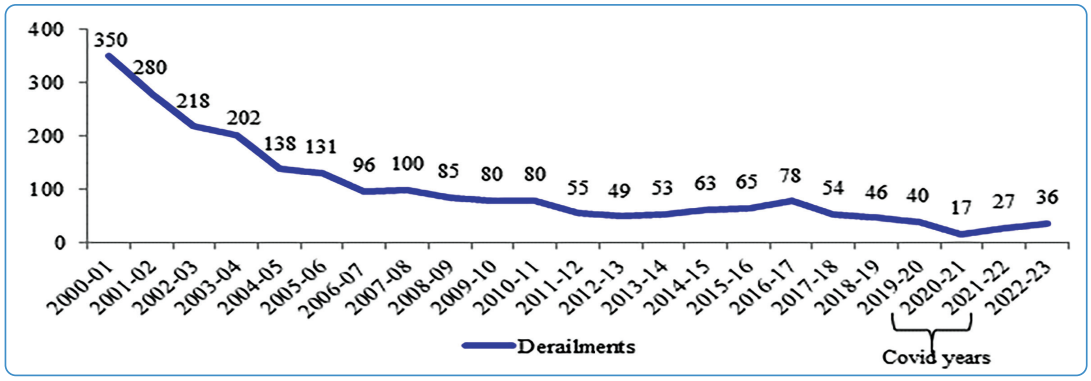


**Fig. 4.2:** Consequential Train Accidents From FY 2000 To FY 2022

### Causes of Railway Accidents

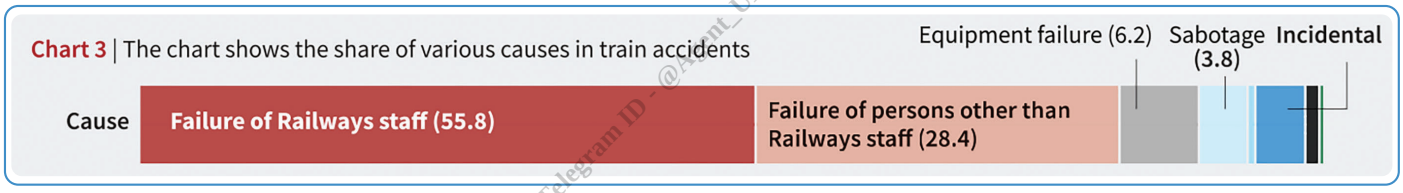


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**Fig. 4.3:** Causes of Railway Accidents

- **Infrastructure Defects:** Poor maintenance, aging, vandalism, sabotage, and natural disasters contribute to defects in railway infrastructure, including tracks, bridges, overhead wires, and rolling stock. Much of the infrastructure was built in the 19th and 20th centuries and has not been adequately upgraded to meet modern standards.
- **Human Errors:** Railway staff responsible for operating, maintaining, and managing trains and tracks may commit errors due to fatigue, negligence, corruption, or a disregard for safety rules. Human errors can lead to issues such as wrong signaling, miscommunication, over-speeding, and overlooking defects or hazards. Data Show among the **consequential train accidents, 55% had occurred due to negligence or failure of the Railways staff. About 28% of accidents were attributed to the failure of persons other than the Railways staff.**
- **Signalling Failures:** Technical glitches, power outages, and human errors can lead to failures in the signalling system. Signalling failures may result in trains running on the wrong track, collisions, overshooting stations, and other safety-related incidents. For example the **Balasore Railway accident.**
- **Natural disasters and weather:** Floods, landslides, and extreme weather events can damage tracks and disrupt operations, increasing accident risks.
- **Socio-economic factors:** Encroachment on railway land and lack of awareness among the public about railway safety procedures further exacerbate the issue.
- **Overcrowded Routes:** Many railway routes operate at over 100% capacity, leading to congestion and overloading. Overcrowding increases the risk of accidents and makes it challenging to manage train movements efficiently.
- **Inadequate Training and Communication Skills:** Insufficient training and communication skills among railway staff can affect their performance and coordination. Well-trained and effectively communicating staff is crucial for ensuring safe and efficient railway operations.



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### Data-Wise

- In 2021, there were 16,431 deaths and 1,852 **injuries from railway accidents**. The majority (67.7%) of incidents involved people falling from trains or collisions with individuals on tracks.
- A steep decline is observed in consequential **train accidents**, dropping from 473 in 2000-01 to 48 in 2022-23. The **average annual accidents** were 171.1 during 2004-14, decreasing to 70.9 during 2014-23.
- The number of consequential **train derailments** declined significantly from 350 in 2000-01 to 36 in 2022-23. The average annual derailments decreased from 86.7 (2004-14) to 47.3 (2014-23).
- A substantial drop is evident from 14,769 **train accidents** (1960-61 to 1970-71) to 1,844 accidents (2004-05 to 2014-15).
- The six-year period between 2015-16 and 2021-22 recorded 449 train accidents, excluding Konkan Railways.

## Impact of Rail Accidents

- **Human Loss:** In the year between 2000-2016, 2297 people lost their life in railway accidents and 6088 people got injured affecting a total of 8385 people in the country. The annual mean data showed that 524 people were affected each year during 2000-2016, out of which, 144 lost their life and 381 left injured.
- **Economic loss:** Economic loss include rolling stock loss, permanent way loss and compensation paid to victims. Between 2000-2016, Indian Railway faced a total loss of **Rs. 86486 Cr. due to accidents.** Thus, Indian Railway lost Rs. 5405 Cr. per year due to accidents. Out of total loss of Rs. 86486 Cr during 2000-2016, Indian Railway paid Rs. 6412 Cr. towards the compensation to the incident victims and rest Rs. 80073 Cr. faced for permanent plus rolling stock. The Indian Railway faced a total loss of Rs. 61620 Cr. during the 16 year under study as a loss due to rolling stock.
- **Environmental Damage:** Accidents involving chemical spillages, flammable or explosive cargoes can cause environmental damage.
- **Property Damage:** Rail accidents can lead to the destruction of public property and consequent financial losses.
- **Disruption of Traffic:** Accidents can disrupt rail and possibly road traffic.
- **Psychological Cost:** Accidents can lead to a loss of public and commercial confidence in the transport system.

## Steps Taken by the Government

- **Rashtriya Rail Sanraksha Kosh (RRSK):** Established in 2017-18 with a corpus of Rs 1 lakh crore for a 5-year period, this initiative focuses on critical safety-related projects, including track renewals, signaling initiatives, and bridge rehabilitation in the railway sector.
- **Technological Upgradation:** Improved design and features of coaches and wagons, including Modified Centre Buffer Couplers, Bogie Mounted Air Brake System (BMBS), and Automatic fire & smoke detection systems.
  - **Linke Hofmann Busch (LHB) Design Coaches:** Lighter and safer coaches for Mail/Express trains based on German technology with better anti-climbing features, fire retardant materials, and enhanced safety features.
- **Kavach (box):** Kavach, an Automatic Train Protection (ATP) system, is an indigenous innovation by Indian Railways. Developed by the Research Designs & Standards Organisation (RDSO), it aims to prevent train collisions. Certified for safety integrity level 4 (SIL-4) operations, Kavach is cost-effective, with implementation costs significantly lower than global counterparts. The system enhances safety by helping loco pilots avoid signal passing and overspeeding, and improves efficiency during inclement weather. Rapid implementation across India's rail network is underway, with a focus on the Golden Quadrilateral rail route.
- **GPS-based Fog Pass Device:** A GPS-enabled device to assist loco pilots in navigating in foggy conditions, providing information about approaching landmarks and alerting the pilot when nearing signals or level crossing gates.
- **Modern Track Structure:** Implementation of stronger and more durable tracks and bridges using technologies like Prestressed Concrete Sleeper (PSC), higher Ultimate Tensile Strength (UTS) rails, and fan-shaped layout turnout on PSC sleepers.
- **Ultrasonic Flaw Detection (USFD):** Non-destructive testing method using high-frequency sound waves to detect and remove faulty rails, reducing the risk of derailments.
- **Mechanization of Track Maintenance:** Automation of track maintenance activities using machines such as track tamping machines, ballast regulating machines, and dynamic track stabilizer to reduce human errors and improve track quality and safety.
- **Interlocking System:** Centralized control of points and signals using electrical or electronic devices, eliminating manual operation by ground staff and reducing the chances of human failure.

### CAG Recommendations for Indian Railways (IR)

- **Adherence to Timelines for Accident Inquiries:** Ensuring strict adherence to scheduled timelines for conducting and concluding accident inquiries to enhance transparency and accountability in the investigation process.

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- **Monitoring Mechanism for Timely Maintenance Activities:** Developing a robust monitoring mechanism to ensure the timely implementation of maintenance activities. Adoption of fully mechanized methods for track maintenance and incorporation of improved technologies to enhance efficiency.
- **Principles for RRSK Funds:** The Railway Administration should follow the guiding principles for the deployment of Rashtriya Rail Sanraksha Kosh (RRSK) funds.
- **Outcome of Framework for Safety Work:** Preparation of a detailed outcome framework for each safety work item. This framework should align with indicative outcomes, enabling an assessment of whether the benefits derived from RRSK funds align with the objectives of the fund's creation.

| Various Committee Recommendations To Ensure Railway Safety In India | |
|---|---|
| Kakodkar Committee (2012) | ❑ Establishment of a non-lapsable Rashtriya Rail Sanraksha Kosh (RRSK) of Rs. 1 lakh crores over 5 years for safety works.<br>❑ Creation of a statutory Railway Safety Authority.<br>❑ Adoption of advanced technologies for track maintenance and inspection.<br>❑ Improvement of human resource development and management.<br>❑ Ensuring independent accident investigation. |
| Bibek Debroy Committee (2014) | ❑ Merger of Railway Budget with General Budget.<br>❑ Outsourcing of non-core activities.<br>❑ Creation of a Railway Infrastructure Authority of India. |
| Vinod Rai Committee (2015) | ❑ Establishment of an independent Railway Safety Authority with statutory powers.<br>❑ Formation of a Railway Accident Investigation Board to conduct independent and impartial inquiries.<br>❑ Creation of a separate Railway Infrastructure Company to own and maintain railway assets.<br>❑ Introduction of a performance-linked incentive scheme for railway employees. |

## Way Forward

- **Prioritize modernization:** Upgrade tracks, signaling systems, and rolling stock with a focus on sturdiness, reliability, and safety features. Invest in advanced technologies like ATP and collision avoidance systems. For example in **Japan High-speed Shinkansen trains leverage advanced collision avoidance systems like automated train control (ATC)** and continuous automatic track signaling, ensuring near-zero accident rates.
- **Increase track capacity:** Explore options like double-tracking and electrification to manage increased traffic and freight movement efficiently. For example In Germany **The Deutsche Bahn network** prioritizes track maintenance and renewal, employing sophisticated track monitoring systems and predictive maintenance techniques to prevent track failures.
- **Enhance training and safety culture:** Implement rigorous training programs for all personnel, emphasizing safe practices and fatigue management. Foster a culture of safety within the railway system where safety takes priority over operational pressures. For example In the **United Kingdom, The Rail Safety and Standards Board (RSSB)** implements rigorous training programmes for all railway personnel, including fatigue management protocols and safety best practices.
- **Improve recruitment and manpower:** Address the personnel shortage by hiring trained professionals and ensuring adequate staffing for all critical roles. In this direction the government has already taken steps with 1,38,948 candidates appointed in the 6 Rozgar Melas held of which 1,10,000 are in the safety category.
- **Invest in weather monitoring and forecasting:** Implement advanced weather monitoring systems and forecasting technologies to predict and prepare for potential disruptions caused by natural disasters.
- **Address encroachment:** Implement strict measures to prevent and remove encroachments on railway land, prioritizing public safety over individual convenience.
- **Raise public awareness:** Launch educational campaigns and awareness programmes to educate the public about railway safety rules, responsible behaviour around tracks, and the dangers of trespassing or ignoring safety warnings.

### Odisha Rail Accident 2023

**Key Lessons from the Odisha Train Accident**

- **Identification of Faults:** The accident stemmed from an undetected fault in the wiring near Bahanaga Bazar Railway Station, emphasizing the need for routine checks and thorough testing of signaling circuits.

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- **Communication and Coordination:** The incident exposed communication lapses and a lack of coordination in the disaster response system, stressing the need for faster initial disaster response by the railways and improved coordination between Zonal Railways and Disaster-Response Forces.
- **Preventive Measures: The investigation report underscores the importance of preventive measures,** citing a past incident in 2022 where corrective actions could have averted the Odisha tragedy. For instance, the **use of automotive systems like KAVACH can be instrumental in averting such incidents.**

# AIR ACCIDENTS

Air accidents are infrequent but highly impactful events, with the majority occurring during take-offs and landings. Rescue and fire services at airports are better equipped to respond to accidents on runways or in undershoot or overshoot areas. However, accidents en route contribute to about 25% of total accidents and have a significantly lower survival rate.

## Causes of Air Accidents

- **Technical Reasons:** The Air India Express Boeing 737 overshot the runway at Mangalore Airport, crashing into a valley and killing 158 people. Investigation revealed faulty altitude sensors and pilot confusion as contributing factors.
- **Human Factors:** Pilot error was also found to be the cause in eight of India's 10 most fatal air crashes that together claimed 1,352 lives.
- **External Factors:** These include Bird strikes, Sabotage and terrorism. An Air India Boeing 787 suffered a bird strike shortly after takeoff from Mumbai Airport, damaging the engine and forcing an emergency landing. Similar bird strike incidents have also occurred in Delhi and Chennai.
- **Weather:** Aviation is highly weather dependent. Weather factors contribute to accidents occurring and enhance the probability and effects of other factors such as heavy weather and poor visibility may increase the possibility of pilot errors and collision with terrain or with other aircraft. Weather-induced rough flights, capable of causing serious discomfort and even injury are a matter of common experience by many passengers.

## Air Accident Risk in India

- **Unlicensed Airports:** According to data from the Airports Authority of India (AAI), the 125 functional airports in India catered to about 14.26 million passengers. Out of this as many as 86 airports have had their license renewed after they met the long checklist of regulations.
- **Prevailing issues:** Poor runway signage and markings that do not conform to international aviation standards even at high-risk airports, narrow perimeter roads around airports, incorrect runway friction testing methods and infrequent testing, flawed rubber removal from runways, faulty HR policies with regard to crew utilization, and a shortage of air traffic controllers.
- **Use of Accident Prone Aircraft:** MiG-21 jets were first introduced by the air force in 1963 to increase its combat ability during the Cold War. Over the years, as they gained the reputation of being the backbone of the air force but also earned names like "widow maker" or "flying coffin" because of their accident-prone nature.

## Impact of Air – Accidents

- **Loss of life and injuries:** According to data primarily sourced from the DGCA's accident investigation reports, since Independence 2,173 people have died in 52 commercial passenger airline accidents that have had at least one fatality. Of these, an **overwhelming 1,740 people, or 80 per cent, died in mishaps that were attributed to pilot error.**
- **Environmental damage:** Air accidents can cause environmental damage by releasing hazardous materials, fuel, and debris into the air, land, and water. Air accidents can also worsen air pollution, especially when they occur in urban areas or trigger fires.
- **Economic losses:** Air accidents can cause economic losses for airlines, airports, insurance companies, and other stakeholders. They can also disrupt air travel, tourism, trade, and business activities.

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### Learning from Charkhi Dadri Plane Accident

**The Incident:** Two planes from Saudi Arabia and Kazakhstan collided in the sky over Charkhi Dadri district of Haryana in **1996, killing at least 349 persons in the deadliest mid-air collision.**

### Who was Responsible?

- **Pilot:** The investigators found that the Kazak Airlines plane was commanded by air traffic control to fly at 15,000 feet, but the pilots made an **unauthorized descent to 14,000 feet, causing the collision.**
- **Miscommunication:** The Airport Authority of India and the Directorate General of Civil Aviation both stated that the Kazakh pilots failed to understand the repeated instructions of the air traffic controller because of their **poor knowledge of English language.**
- **Pre-existing hazards:** The airspace over Charkhi Dadri was known for its congestion and lack of proper air traffic control infrastructure, posing a significant hazard for air travel.

**Lesson Learned:** Upgradation of air traffic control infrastructure, Stricter pilot training, need for Stringent regulations and safety protocols



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## Steps Taken by the Government

- **Increased Manpower and improved work condition:** As per Aviation Minister About 1000 air traffic controllers have been recruited during the last three years taking their number to 3,263. Changes have been proposed to the Civil Aviation Requirement (CAR) pertaining to 'Duty Period, Flight Duty Period, Flight Time Limitations and Prescribed Rest Period.
- **Development of health system capacities at airports under the Atma Nirbhar Swasth Bharat Yojana**: Under this programme, Public Health Units will be strengthened at 32 airports. This program will facilitate smooth movement of pharmaceuticals through air across India as well in other parts of the world.
- **Amendment to Aircraft Rules, 1937:** The Amendment introduces key changes addressing concerns related to the **display of "false lights" in the vicinity of an aerodrome**. This update clarifies that the term "light" encompasses lantern lights, wish kites, and laser lights. The government's jurisdiction over those exhibiting such lights has been extended from 5 kilometers to 5 nautical miles around an aerodrome. Furthermore, it is made explicit that the government possesses the authority to take action against individuals displaying lights that disrupt the safe operation of aircraft or pose hazards to the operating crew.

### Institutional and Legislative Framework on Air Safety in India

- **Directorate General of Civil Aviation (DGCA)(1946):** The DGCA is the national regulatory body for civil aviation in India. It attained statutory status under the Aircraft (Amendment) Act, 2020. It operates under the Ministry of Civil Aviation and is responsible for overseeing and implementing regulations related to air safety, airworthiness, licensing of personnel, and more.
- **Aircraft Accident Investigation Bureau:** AAIB, India is responsible for classification of 'Safety Occurrences' involving aircraft operating in the Indian Airspace into Accidents, Serious Incidents and Incidents. As per the Rule 3 of Aircraft (Investigation of Accidents and Incidents) Rules, 2017 the sole objective of the investigations carried out by AAIB is prevention of accidents and incidents and not to apportion blame or liability.
- **Bureau of Civil Aviation Security (BCAS)(1978):** BCAS is responsible for overseeing and implementing security measures in civil aviation. It plays a crucial role in ensuring the safety and security of airports and aircraft.
- **International Civil Aviation Organization (ICAO) Compliance(1944):** As a founding member since the 1944 Chicago Convention, India's consistent participation in ICAO, including the Provisional ICAO from 1944 to 1947, underscores its commitment to aligning aviation practices with international standards. Adherence to ICAO standards is crucial for maintaining safety and global aviation interoperability.

### Recommendations of the Standing Committee on Air Safety

The Standing Committee on Transport, Tourism, and Culture presented a report on 'Issues related to Safety in the Civil Aviation Sector' on March 31, 2022. The key observations and recommendations include:

- **Airworthiness of Aircraft Engines:** The Committee highlighted the essential need for **adherence to aircraft engine safety regulations,** advocating substantial penalties for airline operators violating rules to ensure airworthiness.
- **Navigation Technology at Airports:** The Committee stressed the importance of the Instrument Landing System (ILS) for safe landings, urging swift installations at all airports and coordination with the Ministry of Defence for permissions, especially at civil enclaves.
- **Preventing Recurrence of Previous Accidents:** It urged advanced technology installations at airports to prevent accidents, particularly in adverse weather, citing incidents in Mangalore (May 2020) and Calicut (August 2020).
- **Investigation of Accidents:** The Committee urged increased budget allocation for the Aircraft Accident Investigation Bureau in 2022-23, emphasizing alignment with global investigation standards and strict timelines for finalizing accident reports to prevent similar incidents.
- **Unmanned Aircraft Systems (UAS):** It recognized drone safety risks, urging the Ministry of Civil Aviation to promptly specify safety features within a strict timeline.
- **Safety of Helicopter Operations:** The Committee noted helicopter accident fatalities, suggesting guidelines for safe operations in adverse weather and improvements in safety and airworthiness checks.
- **Bird Hits:** The Committee noted bird strike incidents, especially at Thiruvananthapuram Airport, recommending universal measures and compliance guidelines from the Ministry of Civil Aviation.

### Ideal Evacuation- The Japan Method

**The Incident and Evacuation**

- On January 2th, 2024, a **Japan Airlines Airbus A350 collided with a smaller Coast Guard aircraft while taxiing at Haneda Airport.**
- All 379 passengers and crew members onboard the A350 were safely evacuated within 18 minutes.

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- The success of the evacuation is **attributed to several factors:**
  - **Swift action by the crew:** Following the collision, the crew immediately initiated emergency protocols.
  - **Effective communication:** Due to the collision, **only three of the eight emergency exits were usable**. Crew members quickly assessed the situation and directed passengers accordingly.
  - **Utilization of evacuation slides:** Slides were deployed efficiently, and passengers were instructed on proper exit procedures.

**Lessons Learned:** The successful evacuation of Japan Airlines flight highlights several valuable lessons

- **Importance of emergency training**: Thorough and regular training for both crew and passengers is essential for effective emergency response.
- **Adaptability and improvisation**: The ability to assess the situation, improvise, and utilize available resources is crucial in unforeseen circumstances.
- **Importance of emergency equipment**: Properly functioning equipment like slides and life jackets can significantly improve the chances of survival.

### Looking Forward

This incident showcases the **importance of robust emergency protocols and the effectiveness of well-trained crew and passengers**. The lessons learned can be applied to further improve aviation safety standards and emergency response procedures globally. Additionally, continued research and development of evacuation technologies and procedures can enhance preparedness for future aviation incidents.

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## Challenges in Mitigation of Air Accidents in India

- **Inadequate infrastructure and regulation:** India needs more trained personnel, modern equipment, and effective oversight to meet the increasing demand for air travel. The **DGCA, the authority responsible for civil aviation safety should enhance enforcing safety standards and monitoring airlines.**
  - DGCA has been managed by the Indian Administrative Service (IAS) lobby, with nine of the regulator's directors general (D.Gs) since 1980 being IAS officers, who do not necessarily have the domain experience.
- **Human factors and organizational culture:** Human factors, such as fatigue, stress, communication, teamwork, and decision-making, are crucial for aviation safety. However, these factors are often overlooked or disregarded by the aviation industry and authorities. There is a need for more education and training on human factors and their impact on performance and safety. There is also a need for a positive safety culture, where errors are reported and learned from, rather than punished or hidden. **For example, in 2019, a SpiceJet flight overshot the runway at Mumbai airport, causing damage to the aircraft and the runway. The investigation revealed that the pilot had violated the standard operating procedures and had a history of disciplinary issues.**
- **Outdated norms:** India's biggest aviation issues is that its regulations are outdated and not in sync with the rest of the world. The world either follows the FAA or the EASA [European Union Aviation Safety Agency]. While West Asia and even Bangladesh follow EASA regulations, China follows the FAA

## Way Forward

- **Enhance the implementation of global and regional safety plans: ICAO** has developed the Global Aviation Safety Plan (GASP) and the Regional Aviation Safety Groups (RASGs) to provide guidance and coordination for States and stakeholders to address the most pressing safety issues and achieve the safety targets. These plans and groups need to be fully implemented and supported by adequate resources and political will.
- **Strengthen the safety oversight and regulation:** Authorities need to ensure that they have effective and independent safety oversight systems, that they comply with the ICAO standards and recommended practices, and that they enforce the safety regulations and procedures for all operators and service providers. They also need to harmonize their safety requirements and practices with other regions and countries to avoid inconsistencies and gaps.
- **Promote the safety management and culture:** Operators and organizations need to adopt and implement safety management systems (SMS) that identify and mitigate the safety risks and hazards in their operations. They also need to foster a positive safety culture that encourages the reporting and learning from errors, incidents, and accidents, and that rewards safe behaviors and practices.
- **Improve the human factors and training:** Pilots and other aviation personnel need to receive adequate and continuous training on the technical and non-technical skills required for their roles, such as upset prevention and recovery training (UPRT), crew resource management (CRM), and fatigue management. They also need to be aware of the human factors that can affect their performance and safety, such as stress, fatigue, communication, teamwork, and decision-making, and how to cope with them.
- **Leverage the technology and innovation:** States and operators need to invest in and adopt the latest technology and innovation that can enhance the safety and efficiency of their operations, such as underwater locator devices, cabin safety improvement, aircraft fire extinguishing systems, runway safety programme, global reporting format, online airworthiness information network, clean aircraft concept, and aircraft type designator. They also need to ensure that the technology and innovation are compatible and interoperable with the existing systems and equipment.



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## FIRE DISASTERS

Fires in buildings, whether residential or commercial, are the most common occurrences among fire disasters, often becoming uncontrollable due to the presence of combustible materials like wood, cloth, paper, plastics, chemicals, and flammable substances such as cooking gas and kerosene oil.

### Causes of Urban Fires in India

- **Under-equipped fire services in the country: According to the Home Ministry report** 8,550 fire stations needed in the country, a little more than 2,000 are in place — a shortage of about 65 per cent. Urban areas alone require an additional 4,200 fire stations just to meet the minimum standard for response.
- **Poor working conditions in the informal urban areas:** The quality of jobs is very poor in informal establishments, especially for women. It is also often reported that there is poor enforcement of the labor laws by the enforcement machinery as the corruption has entered into administration. For example the 2022 **Mundka fire incident.**
- **Lack of Smoke Management:** Since high-rise buildings usually comprise large enclosed spaces or voids, even a small fire can become a fire hazard due to the lack **of smoke management and warning mechanism through emergency lighting.**
- **Vulnerability Analysis:** Due to inadequate regulation and enforcement of **National Building Code 2016, lack of vulnerability analysis** buildings leads to urban fire as vulnerability directly affects preparedness, response, and recovery.
- **High risk:** India, according to the **India Risk Surveys 2022**, held 4th position globally in fire incidents, particularly in the Northern and Western regions.
- According to the **National Fire Services Study,** every 5th fire-related death worldwide in 2017 occurred in India.

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#### Landfill Fire

**Why do landfills catch fire?**

- **Low Waste Processing:** The rate of processing in India's cities is far lower than the rate of waste generation, so unprocessed waste remains in open landfills for long periods. India's municipalities have been collecting more than **95% of the waste generated in cities but the efficiency of waste-processing is 30-40% at best.** This openly disposed waste includes flammable material like low-quality plastics, which have a relatively higher calorific value of about 2,500-3,000 kcal/kg (compared to around 8,000 kcal/kg for coal), and rags and clothes. In summer, the biodegradable fraction composts much faster, increasing the temperature of the heap to beyond 70-80° C.

**Solution**

- **Completely cap the material using soil and close landfills in a scientific manner:** This solution is unsuitable in the Indian context as the land can't be used again for other purposes. Closed landfills have specific standard operating procedures, including managing the methane emissions.
- **Clear the piles of waste through bioremediation:** This basically means excavating old waste and using automated sieving machines to segregate the flammable refuse-derived fuel (RDF), such as plastics, rags, clothes, etc., from biodegradable material. The recovered RDF can be sent to cement kilns as fuel, while the bio-soil can be distributed to farmers to enrich soil. The inert fraction will have to be landfilled. However, implementing a bioremediation project usually takes up to two or three years, necessitating a short-term solution for landfill fires in the summer.

### Impacts Associated with Fire incidents in India

- **Loss of life and injury:** Fire incidents can be fatal or harmful to many people, especially women who are more exposed to domestic fires. According to a world bank report every year, **more than 180,000 people die in fires or from burn-related injuries worldwide. Over 95% of these deaths and injuries occur in low- and middle-income countries,** where risks rise in proportion to rapid urbanization.
- **Property damage and economic disruption:** Fire incidents can ruin or damage valuable assets and affect economic activities. For instance, in 2021, a fire at a chemical factory in Maharashtra caused a loss of Rs 40 crore and disrupted the nearby industries.
- **Infrastructure damage and public safety:** Fire incidents can impair essential infrastructure, such as buildings and public utilities, and jeopardize public safety. It can also affect the power supply and water pipes in the area.
  - **Environmental impact and health hazards:** Fire incidents can contaminate the environment and create health risks, especially when they involve industrial plants and hazardous materials. For instance, in **2018, a fire at a landfill site in Delhi released toxic gases** and smoke, affecting the air quality and the health of the residents.



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### 1997 Uphaar Cinema Fire

Early morning on that ill-fated day, the larger of the two transformers installed on the ground floor of the Uphaar Cinema building caught fire. While this fire was put out quickly, it damaged the transformer, quick repairs were carried out. The shoddiness of these repairs was reportedly behind the much larger fire later in the day. At around 5 pm, the transformer caught fire again, after one of the repaired cables came loose and caused intense sparking. Since the transformer did not have an oil soak pit, as required under regulations, the burning oil spread outside. Thus, cars parked even at a distance of no more than a meter from the door of the transformer were also engulfed in flames. By now, the blaze had gone out of control. While the fire itself need not have been the cause of death for so many, the cinema was woefully unprepared for such a situation. Smoke entered the cinema hall and as the theater lost power, there was complete chaos. While the viewers seated in the lower floor were able to escape, people in the balcony were trapped. A total of 59 people died of asphyxiation. Many were also injured in a stampede.

### Lapses that Caused the Uphaar Cinema Tragedy

- **Generator that caught fire was installed after flouting many norms:** Not only did it not have adequate safety features, it was placed in what was being used as a parking lot. This meant the fire could not be easily contained as cars with tanks full of highly inflammable gasoline started catching fire. Further, as the investigation later revealed, the generator had not undergone periodic maintenance as required by law.
- **Hall had inadequate safety measures and procedures in place**: There were no exit lights, foot lights, or emergency lights in the cinema – when the building lost power, the hall became pitch dark. There was also no public announcement system to alert the movie-goers of the fire. In the darkness of the cinema hall, it took a significant while for viewers to even realize there was a massive fire in the building.
- **Lock exits:** Many exits were locked and gangways blocked due to the hall making unauthorized extensions to increase seating capacity. There were also various unauthorized businesses being run within the building, occupying spaces that were supposed to be empty.

## Steps Taken by the Government for Fire Safety in India

- **Scheme for Expansion and Modernization of Fire Services in the States:** The measures included in the scheme provides setting up of new fire stations, strengthening of State Training Centres and capacity building, provisions for modern fire-fighting equipment, strengthening of State Headquarters and Urban Fire Stations, technological upgradation and installation and augmentation of online system etc. **Fund allocation under the scheme is on a cost sharing basis.** While the Centre will provide Rs. 5000 crore to the States for identified activities, the States' contribution will be of Rs. 1387.99 Crore.
- **Kerala State government guidelines:** Government offices have been directed to install fire protection devices and maintain digital copies of important documents.
  - **Smoke detection and alarm systems with hooters should be installed in the record rooms** and other rooms where important records are kept. Such locations should also be equipped with automatic fire detection sensors with hotlines to the nearest fire station.
  - **Record rooms where priceless documents are preserved, server rooms and UPS rooms should have CO2/FM200-based total flooding systems operating on smoke/heat sensors.** Multi-storeyed buildings should be equipped with fire protection mechanisms as prescribed by the National Building Code.
  - Waste material should not be kept in the corridors, terraces, and staircases of the buildings. They should be disposed of at regular intervals. Old electrical equipment should be replaced and it should be ensured that the offices are equipped with Earth Leakage Circuit Breaker (ELCB)/Residual Case Circuit Breaker (RCCB).
- **The Building Bye-Laws, 2003:** Under the Modern Building Bye-Laws of 2003, the responsibility for fire clearance lies with the Chief Fire Officer at each point. Development Authorities are required to submit building plans to the Chief Fire Officer for clearance.
- **National Building Code (NBC) of India, 2016:** It the NBC is a recommendatory document which is published by the **Bureau of Indian Standards,** State governments are expected to integrate its provisions into local building bylaws, thereby making the recommendations mandatory. It encompasses administrative regulations, general building requirements, fire safety measures, and provisions for structural design and construction safety.
- **The Disaster Management Act of 2005:** Empowers the National Disaster Management Authority (NDMA) and State Disaster Management Authorities to develop policies and plans for disaster management, including fire emergencies.
- **National Disaster Management Authority (NDMA):** NDMA guidelines set forth fire safety requirements for public buildings, including hospitals. Design guidelines cover aspects such as maintaining adequate open space,

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exit mechanisms and stairs, and conducting evacuation drills to ensure a minimum level of preparedness.

## Challenges in Mitigation

- **Regulatory Lapse:** In most parts of the country, a fire-safety inspection is, at best, a once-in-a-few-years affair. This means that after obtaining a license, owners of shops, restaurants and other private buildings make changes in the sanctioned layout plans that very often compromise the fire-preparedness of their premises. **For example, Karol Bagh Hotel Fire 2019**
- **Limited resources and infrastructure**: The fire services in India face a shortage of manpower, vehicles, equipment, and funds to deal with the increasing number of fire incidents. The Fifteenth Finance Commission(XV-FC) has also noted that **fire services in the country lack resources and are ill equipped to provide adequate fire safety cover to the population.** Therefore, recognizing the need for expansion and modernization of Fire Services, XV-FC recommended a **provision of Rs. 5,000 crore for strengthening fire services at the State level.**
- **Lack of awareness and preparedness:** Many people are not aware of the fire hazards and the preventive measures they can take to avoid them. For example, some people do not know how to use fire extinguishers, or how to escape from a fire situation.
- **Environmental and health impacts**: Fire accidents can cause severe damage to the environment and the health of the people, especially when they involve industrial plants and hazardous materials. For example, some fire accidents can release toxic gases, smoke, and ash, which can affect the air quality and the respiratory system of the people.

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## Way Forward

- **State-specific Fire Acts:** The urgent enactment of state-specific Fire Acts, based on the 2019 model bill, is imperative for comprehensive regulations in states lacking adequate fire safety measures, ensuring the protection of lives and property.
- **Adherence to Standards:** Strict compliance with National Disaster Management Guidelines for fire services, mandating scaling, equipment, and training standards.
- **Provide adequate means of escape:** The first rule of fire management requires sufficient escape routes out of the building, in accordance with its scale and occupancy. The number, size and location of exits are specified in the National Building Code (NBC) 2005, a detailed set of guidelines for constructing, maintaining and operating buildings of all types. Office occupiers must additionally ensure that staircases, stairways and corridors are well-maintained, ventilated and free of obstacles in order to be effective in an emergency.
- **Install smoke detection systems:** The first few minutes of a fire are crucial in containing it. Automatic fire alarm systems such as smoke and heat detectors are mandatory elements in international building codes, and particularly useful in spotting fires during times when occupancy in the building is low.
- **Maintain smoke suppression system:** Fire extinguishers are only useful if they work, so check them regularly. High-rise buildings, which are harder to access and evacuate, should consider installing automatic sprinkler systems. The **National Fire Protection Association (NFPA),** a US-based non-profit body, estimates that automatic suppression systems **lower the cost of damage by 60%. Karguppikar** endorses their use, admitting that "the fire in one of the rooms on the 18th floor of the Oberoi was extinguished by its sprinkler system and it was an eye-opener for all of us".
- **Conduct regular fire drills:** Preventing panic in an emergency is as important as staying away from flames and fumes. Regular fire drills familiarize people with emergency evacuation methods at little cost. Nominate a fire safety officer in every building to ensure that this becomes standard operating procedure.
- **Use flame-retardant materials in interiors:** Materials used in the interiors can save or endanger lives. The combination of wood, paper and textiles makes workstations highly combustible. Fabrics can be made flame-retardant, however, so that they self-extinguish when lit. An increasing number of companies, especially multinationals, request such fabrics despite their price premium, according to data from Indian office furniture manufacturer BP Ergo. Stringent fire regulations abroad make it necessary for US furniture makers such as Herman Miller to provide only fire-tested fabrics.
- **Comply with National Building Code:** "Green buildings" are in vogue but safe structures are sadly not. Both the Mumbai Fire Brigade and BMC commissioner concede that 80% of buildings likely violate accepted codes of building safety, with ignorance and personal whims leading to illegal modifications after gaining requisite occupancy permission.

### NDMA Guidelines

- The National Disaster Management Authority (NDMA) has issued the National Disaster Management Guidelines on Scaling, Type of Equipment and Training of Fire Services under Section 6 of the DM Act 2005. These guidelines aim to standardize and revamp the fire services in the country and ensure effective, efficient and comprehensive management of fire incidents.
- The NDMA guidelines cover various aspects of fire services, such as organizational structure, manpower, equipment, training, communication, fire prevention, fire safety audit, fire investigation, fire research, and disaster response.



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- The NDMA guidelines also provide the norms and standards for scaling, type of equipment and training of fire services based on the population, area, risk profile, and response time of different states and cities.
- The NDMA guidelines are intended to serve as a reference document for the central and state governments, urban local bodies, fire service organizations, and other stakeholders involved in fire management.

## DAM SAFETY

Dam safety in India is a critical aspect given the extensive network of dams that play a vital role in water management, irrigation, and power generation. India's global rank stands at third place with 5334 large dams currently operational, and an additional 411 dams are under construction. Alongside these, there are numerous smaller dams. These structures play a crucial role in ensuring the water security of the country.

### Data-Wise

- India possesses 5745 large dams, as per the 2019 National Register of Large Dams by the Central Water Commission. Among them, 5334 dams are completed and operational, and 411 are currently under construction.
- Notably, 227 large dams are over 100 years old, with approximately 18% falling within the age range of 50 to 100 years.

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### Causes of Dam Failure

- **Overtopping:** This occurs when the water level in the reservoir rises above the capacity of the dam, spilling over the top and eroding the structure. It can be caused by several factors, including Heavy rainfall or extreme weather events, Blocked spillways (debris or ice) and Design flaws. For example The **1979 Machchhu dam failure.**
- **Foundation defects:** The foundation plays a crucial role in the stability of any dam. Issues with the foundation can lead to cracks, settlement, and ultimately, failure. This happen due to:
  - **Geological instability:** Faults, underground cavities, or weak rock formations can undermine the dam's foundation and compromise its integrity.
  - **Erosion:** Wiping of the foundation by water or the movement of sediment can weaken the support for the dam, increasing the risk of collapse. The **2019 Tiware dam failure in Maharashtra,** India, was attributed to the erosion of its earthen foundation, potentially due to a combination of factors, including heavy rainfall and pre-existing cracks.
  - **Excavation activities:** Construction or mining activities near the dam can disturb the surrounding soil and destabilize the foundation.
- **Climate change:** Climate change is causing the glaciers in the Himalayas to melt at an alarming rate. This melting ice is creating more glacial lakes, and it is also making the slopes of the mountains more unstable. These factors are likely to increase the risk of dam failures in the future. **For example 2023 Teesta Dam Failure (2023)**
- **Piping:** This type of failure occurs when water seeps through the dam, eroding the soil and creating channels or "pipes" within the structure. This happens due to **Defective drainage systems and Faulty construction materials.**
- **Trends all over the world:** According to the International Commission on Large Dams (ICOLD), approximately a third of the dam failures worldwide occur due to **floods exceeding the design capacity of dam spillways**. ICOLD (1995) reports that, worldwide, overtopping is the leading cause of dam failure (32%) followed by internal erosion (27%). In India, on the other hand, internal erosion (breaching) accounts for the maximum number of dam failures (44%), followed by overtopping (25%) (Dam Safety Organisation, Central Water Commission, Government of India.

### Risks Associated with Dams in India

- **Rapid Growth in Dam Numbers:** The exponential growth in the number of large dams in India, from fewer than 300 at independence in 1947 to almost 6000 indicates a substantial increase in exposure to potential hazards.
- **Aging Infrastructure:** India has almost **6,000 large dams and about 80% of them are more than 25 years old and carry safety risks.** Apart from this, 220 large dams have surpassed the age of 100 years. Among the 70 large dams classified as nationally important, 15 are over 50 years old, with 3 of them exceeding 80 years of age. This aging infrastructure raises concerns about their ability to withstand the impacts of climate change, especially in the context of changing precipitation patterns.
- **Climate Change Impact:** Dams built in an era when the full effects of climate change were not understood may not be adequately designed to handle large changes in precipitation patterns. The potential intensification of floods due to climate change poses a risk to the structural integrity of older dams.
- **Population Exposure:** The growth of settlements around dams, driven by expectations of a reliable water supply, increases the potential impact of dam failures. With every new dam constructed, more people and property are exposed to flood hazards resulting from potential dam failures.



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- **Historical Dam Failures:** The occurrence of 23 major dam failures between 1960 and 2010, resulting in significant loss of life and property damage, underscores the real and historical risks associated with dams in India. The Machchu Dam failure in 1979, which claimed over 2000 lives, serves as a stark reminder of the potential consequences of dam failures.

## Impact of Dam Failure

- **Flooding:** A dam failure typically results in a sudden and uncontrolled release of water, leading to severe flooding downstream. This can cause extensive damage to properties and infrastructure.
- **Human Casualties:** Dam failures can result in a significant loss of life. For instance, the **1975 failure of the Banqiao Reservoir Dam in China** resulted in an estimated 171,000 fatalities.
- **Economic Consequences:** The economic impact of dam failures can be substantial. Damage can extend beyond the dam itself, affecting other infrastructure such as roads, bridges, and water systems, leading to millions of dollars in costs.
- **Environmental Impact:** The abrupt release of water can cause considerable environmental damage. This includes the destruction of wildlife habitats and alterations to the landscape.
- **Displacement:** Large-scale dam failures can lead to the displacement of people.
- **Damage to Infrastructure:** Dam failures can impair various infrastructure systems, including roads, bridges, and water systems. This can disrupt essential services and further contribute to the economic impact. **For example** The **GLOF that hit the 1200-MW Teesta-III in October 2023 also severely damaged two NHPC projects, the 510 MW Teesta-V, and the under-construction 500 MW Teesta-VI.**

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## Steps Taken By the Government

- **Constitutional Mechanism:** Under the 7th Schedule of the Constitution of India, water and water storage is a state subject. Therefore, legislating dam safety is the responsibility of state governments. However, the Central Government can enact legislation governing dams in three scenarios.
  - **If a project affects multiple states or international treaties.** Thus, the Central Government can pass legislation regulating dams whose catchment area or downstream affected areas span multiple states or international borders.
  - If **two or more states pass a resolution** requiring such a law. In 2010, Andhra Pradesh and West Bengal passed resolutions requiring a law on dam safety.
  - The **Central Government can legislate on matters related to the protection of the environment under the Environment Protection Act,** 1986. Since dams and dam failures can have a significant impact on the environment, the Central Government can regulate some aspects of dam safety.
- **Central Water Commission (CWC):** It provides technical expertise and guidance on all matters related to dams. It is tasked with research into dam safety, developing standards for dam design and operations, and it is involved in the process of granting environmental clearance to dam construction projects.
- **The Dam Safety Act, 2021:** The Act listed key responsibilities and mandated that national and State-level bodies be established for implementation. It said a **National Committee on Dam Safety** would oversee dam safety policies and regulations; a **National Dam Safety Authority** would be charged with implementation and resolving State-level disputes; the Chairman of the Central Water Commission (CWC) would head dam safety protocols at the national level; a **State Committee on Dam Safety** (SCDS) and State Dam Safety Organisation (SDSO) would be set up.
  - **State Responsibility:** Provisions require States to classify dams based on hazard risk, conduct regular inspections, create emergency action plans, institute emergency flood warning systems, and undertake safety reviews and period risk assessment studies. States were asked to report and record incidents of dam failures.
  - **Punishment:** Failure to comply with any provision of the Act is punishable with imprisonment and/or fines, and if such obstruction or refusal to comply with directions results in loss of lives or imminent danger thereof, **the entity shall be punishable with imprisonment for a term which may extend to two years.** For example, in February 2023 the Sikkim High Court ordered the Gati Hydropower Project company to pay ₹70 lakh to two widowed mothers, for non-compliance with the Dam Safety Act.

## Challenges in Mitigation

- **Lacking Implementation:** Dam safety is a function of many parts which include designing and constructing dams that adhere to safety margins, maintaining and operating them per guidelines, recording data in real-time in an accessible format, forecasting hazardous events and instituting emergency plans, to name a few. The **Sikkim GLOF reveals poor compliance at all levels, from the dam's design to the spillway capacity (which controls the release of water from a reservoir).**
- **No Regular Hazard Profiling:** Hazard profiling and regular assessment are also mandated by the 2021 Act. Periodic reviews are expected to bring forth fresh inundation maps and new rule curves (which determine the capacity



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of dam reservoirs), all of which contribute towards the safety of the downstream areas. Spillway capacity and other metrics should be reviewed every five years or so, but as per experts periodic reviews are often not conducted or if they are, their findings are not not easily available in the public domain.

- The 2021 Act requires dam builders to conduct comprehensive dam safety evaluations, but there is no standardization of how the failure is analyzed and reported.

- **Lacking Transparency:** The Dam safety Act fails to incentivise transparency. A robust DSA should allow different stakeholders to access information easily, but India's framework falls short. **Transparency is further obstructed when national and State bodies comprise government employees and engineers who worked on these projects,** compromising objective decision making and lacking people with a proven track record of taking independent decisions.
- **Management of Multiple Dams**: Larger river basins such as the Krishna, Godavari have multiple dams or chains of dams making analysis difficult. For better management , communication between central, state, district, local and community levels needs to be enhanced.

## Way Forward

- **Enforcement of Dam Safety Act, 2021:** This act provides a comprehensive framework for proper surveillance, inspection, operation, and maintenance of specified dams to prevent dam failure-related disasters. There is a need for proper implementation of the newly formed act.
- **Risk Assessment:** Comprehensive risk assessments, including climate change and geological stability, are essential for identifying and mitigating the potential hazards and vulnerabilities of dams.
- **Hazard Profiling:** Hazard risks are influenced by climate change and urbanization, but **reviews are often overlooked or not shared publicly.** There is a need to conduct regular hazard profiling of dams and their catchments, and to disseminate the information to the relevant stakeholders and the public.
- **Enforce Legally Binding Standards**: The government needs to institute legally binding standards for conducting and reporting dam failure analysis, which is currently not mandatory.
- **Data Sharing:** Regular sharing of dam-related data between the states and the centre, which needs to be made publicly available for transparency, and for facilitating research in dam safety. This would also help in developing a national database of dams and their characteristics, which is currently lacking.

# CROWD MANAGEMENT (STAMPEDE)

Crowd management is the organized planning and oversight of people's movement, assessing venue capacity, entry points, and activity patterns. A stampede, characterized by a rapid and uncontrolled surge in a crowd, often results in injuries and fatalities due to factors like excitement, panic, or perceived threats. Effective crowd management strategies are essential to prevent stampedes and ensure the safety of individuals during large gatherings. This involves meticulous planning, communication, and safety measures.

### Data-Wise

- On average since 2001, there have been approximately 19 stampedes each month since the year 2000, resulting in an average of 14 deaths per incident, according to National Crime Records Bureau (NCRB) data.
- Number of Accidental Deaths & Suicides during 2022, stampede incidents reduced by 76% compared to 2021, with 22 fatalities and 16 injuries reported in 2022.
- In 2022 at least 12 people died and more than a dozen got injured in a stampede at Mata Vaishno Devi Temple in J&K.

## Causes of Crowd Disaster (Stampede)

- **False Rumors:** 110 pilgrims died during the Hindu festival of Navratri when a stampede broke out near the Ratangarh Mata Temple in Madhya Pradesh following rumors that a bridge was collapsing.
- **Poor crowd management:** In 2023 **A. R Rahman** concert venue was overcrowded, exceeding the expected capacity. This resulted in many people being unable to enter the venue and some who entered facing difficulty in movement. The alleged **overselling of tickets led to a stampede-like situation, indicating a potential lack of proper crowd control measures to manage the large and dense crowd.**
- **Inadequate space allocation:** A stampede on a footbridge at a Mumbai railway station in 2017 left 22 people dead and injured more than 301. The tragedy occurred during the morning rush hour at Elphinstone station, which connects two major local lines. It was triggered by overcrowding and people seeking shelter from monsoon rains.
- **Insufficient safety team deployment and lack of cooperation hinder effective crowd control:** In 2022 in a football stadium in Malang, East Java, 133 people were killed including more than 40 children. Police had tried to fend off fans with teargas and many panic-stricken victims were crushed or suffocated while trying to use closed or too-narrow exit doors.

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## Risks Associated with Crowd Incidents in India

- **Religious Places in Risk Prone areas:** Most of the religious festivals are located in areas like banks of rivers, hilly terrains or mountain tops. These areas lack proper pathways, posing a geographical risk to the pilgrims. A 2013 study published by International Journal of Disaster Risk Reduction (IJDRR) points out that religious gatherings and pilgrimages have been venues for 79% of the stampedes in India.
- **Inadequate On-site Medical Care:** The absence of immediate medical attention can worsen injuries. India has a little over one million modern medicine doctors to treat its 1.3 billion people.This shortage of healthcare providers and infrastructure can lead to inadequate on-site medical care during crowd incidents.
- **Lack of Registration and safety system:** In developed countries, there is a safety system which is in place. Organizers have to approach local authorities to get a kind of license to have the mass gathering. After that, the authorities, after looking at the capacity of the venue, issued a certificate to the organizers licensing them. **In India, there is a lack of safety, licensing and registration systems.**
- **Infrastructure Issues:** Rapid urbanization and population growth can strain infrastructure, struggling to accommodate the influx of people.
- **Restricted Access Points**: Limited access points can create bottlenecks, especially on bridges, ferry terminals, or riverbanks.

## Impacts of Crowd Incidents

- **Loss of Life and Injuries:** According to the National Crime Records Bureau figures, from 2000 to 2013, almost 2,000 people died in stampedes.
- **Law and Order Situations:** Crowd incidents can disrupt law and order, necessitating a review of India's crowd control laws and policing. This was evident during the violence at Aligarh Muslim University and the widespread protests following the 2019 Citizenship Amendment Act, which saw significant vandalism and arson in Delhi.
- **Damage to Reputation:** The country's reputation can be tarnished in the eyes of the international community.
- **Financial Constraints:** Managing large crowds, especially during religious festivals, often involves financial challenges.
- **Lack of Knowledge:** There is a disparity in crowd safety knowledge between religious festivals and sports events.

## Challenges in Mitigating Crowd Incidents in India

- **Planning and Preparedness:** There is often a lack of planning and preparedness for mass gathering events, which can lead to crowd disasters.one for instance components like Financial Constraints and technology hinders preparedness.
- **Population Growth:** The rising number of people visiting religious and commercial sites, combined with a lack of management and mitigation plans for mass gatherings, poses a significant challenge.
- **Infrastructure:** Infrastructure challenges, such as temporary structures and inadequate pedestrian crossings, can intensify crowd incidents. For instance, a 2023 stampede at Surat railway station was triggered by overcrowding. Similarly, rapid urbanization, especially during religious festivals, puts a strain on infrastructure, struggling to manage large crowds.
- **Electric/Fire Hazards:** Mishandling of firecrackers or poor electrical wiring are common triggers for stampedes.
- **Safety Team Deployment:** Insufficient deployment of safety teams can lead to drastic measures, such as the use of tear gas.

## Way Forward

- **Context-Driven Interventions:** India should be capable of implementing complex, context-driven crowd control interventions and automated tools.
- **Crowd Management Strategy:** Establishing an effective crowd management strategy can help control threats and reduce losses. It includes - Understanding need, risk assessment, Emergency plan and Robust communication.
- **Technology Utilization:** The incorporation of flexibility and the use of proven, cutting-edge technology can be effective in managing crowds. For instance AI models to predict and simulate, Mobile applications facilitating schedules and emergency alerts, Drones etc. For example Finland has been conducting practical research into using AI for everything from regional population planning to crowd control. Local authorities and the police force are assessing the viability of using AI when hosting events like music festivals and sporting events.
- **Capacity Development:** All states should act promptly to create crowd disaster management plans, adhering to the standards set by the National Disaster Management Authority (NDMA).
- **Pilot Projects:** Pilot projects, like the one established at Sabarimala in Kerala, can provide valuable insights for crowd control, taking into account the unique characteristics of each event or location.

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| Event Planning and Crowd Management Guidelines By NDMA | |
|---|---|
| **Understanding Venue, Visitors, and Stakeholders** | ❑ Identify the type of event (religious, educational, sports, music, political, etc.).<br>❑ Analyse crowd demographics (age, gender, economic background) and motives (social, academic, religious).<br>❑ Assess venue characteristics (location, topography, temporary or permanent, open or closed).<br>❑ Recognize the roles of stakeholders (NGOs, local neighbours, administrators). |
| **Crowd Handling** | ❑ Regulate traffic around mass gatherings; Provide route and emergency exit maps; Implement barricades for crowd control; Follow snake line approach for large queues. |
| **Safety and Security** | ❑ Ensure authorised electricity use, follow fire safety guidelines, and employ CCTV and mini UAVs for crowd monitoring. |
| **Communication** | ❑ Install a public address system with loudspeakers at crowded points for effective communication. |
| **Medical and Emergency Care** | ❑ Establish medical first-aid rooms and emergency operations centres to address post-disaster emergencies. |
| **Role of Event Managers** | ❑ Develops, implements, reviews, and revises a disaster management plan in coordination with local administration and police. |
| **Role of Civil Society** | ❑ Involve NGOs and civil defence in disaster response in traffic control, medical aid, and resource mobilisation. |
| **Role of Police** | ❑ Actively participates in venue assessment and preparedness checks, and guides crowd and traffic movements. |
| **Capacity Building** | ❑ Enhance security personnel training through drills and periodic assessments for effective crowd disaster prevention. |

## BIOLOGICAL DISASTERS (EPIDEMICS) IN INDIA

A biological disaster refers to situations where there is a widespread occurrence of disease, disability, or death among humans, animals, and plants, caused by toxins or diseases resulting from live organisms or their products. These disasters can take the form of natural events such as epidemics or pandemics, or they can be man-made through the intentional use of disease-causing agents in Biological Warfare (BW) operations or incidents of Bioterrorism (BT). **Some of the examples of Biological Disasters** include Infectious diseases such as COVID-19, the disease caused by the novel coronavirus; Severe Acute Respiratory Syndrome (SARS); Middle East Respiratory Syndrome (MERS); and the diseases caused by the Ebola, Nipah, and Zika viruses.

| Types of Biological Disasters | |
|---|---|
| **Natural** | Epidemics that significantly impact a large number of individuals and spread across a continent or globally. |
| **Man-Made** | These disasters arise from intentional or unintentional human actions, such as Biological Warfare and Bioterrorism, lead to widespread biological disasters. |

### Difference Between Epidemic and Pandemic

**Epidemic** affecting a disproportionately large number of individuals within a population, community, or region at the same time, examples being Cholera, Plague.

**Pandemic** is an epidemic that spreads across a large region, that is, a continent, or even worldwide of existing, emerging or reemerging diseases and pestilences, example being Influenza H1N1 (Swine Flu).

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### Causes of Epidemics

- **Infectious Agents:** Pathogens like bacteria, viruses, fungi, and parasites can rapidly spread, for instance COVID19, Indian Black Fungus etc.
- **Globalization and Travel:** Increased global connectivity facilitates swift disease transmission across borders.
- **Environmental Factors:** Changes in climate, deforestation, and altered ecosystems impact disease vectors. The thawing of permafrost due to global warming has been linked to the re-emergence of ancient diseases. For example, in 2016, an outbreak of anthrax occurred in the Siberian Yamalo-Nenets region, during which several people were hospitalized. The reason for this outbreak is believed to be the high temperatures in this region that year, going up to 35°C.
- **Population Density:** High-density living fosters rapid disease transmission, especially in urban areas.
- **Poor Sanitation and Hygiene:** Inadequate sanitation and hygiene practices contribute to waterborne diseases. According to WHO, Poor sanitation is linked to transmission of diarrhoeal diseases such as cholera and dysentery, as well as typhoid, intestinal worm infections and polio.
- **Antimicrobial Resistance:** Misuse of antibiotics (direct human consumption or Agriculture) leads to drug-resistant strains of infectious agents. Some of the



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examples include Tuberculosis, MRSA (methicillin-resistant Staphylococcus aureus) and Clostridium difficile etc.

- **War and Conflict:** Armed conflicts disrupt healthcare systems and contribute to epidemics.
- **Lack of Vaccination and Healthcare Infrastructure**: Insufficient access to healthcare services and vaccinations leaves populations vulnerable. A UNDP analysis reveals extreme vaccine inequity, with less than 1% of populations in vulnerable Sub-Saharan African countries, including Burundi, the Democratic Republic of the Congo, and Chad, fully vaccinated. The WHO highlights a global disparity in essential vaccine access, with HPV vaccines, crucial in combating cervical cancer, introduced in only 41% of low-income countries, despite these countries shouldering the majority of the disease burden.
- **Zoonotic Transmission:** These illnesses are often caused by bacteria, viruses, parasites, or fungi when people touch afflicted animals or their habitats. Some examples of zoonotic diseases: Rabies, Lyme disease, COVID-19, West Nile fever etc.

## Risks of Biological Disaster in India

India is especially vulnerable to such infections because of its geographical position, large population, low healthcare spending, minimal expenditure on research that benefits public health, weak coordination between central and state health authorities, limited involvement of private actors, poor awareness of biosecurity, and the shaky state of public health infrastructure.

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### India Faces Three Major Biological Threats

- **Naturally Occurring Infections:** Given India's climate conditions, the country is vulnerable to vector-borne diseases such as malaria and dengue fever, among others. A high-density livestock population and a poorly guarded animal-human interface make India susceptible to zoonotic infections such as avian influenza, commonly called bird flu; pig influenza, commonly called swine flu; Nipah virus disease; and coronavirus diseases, such as COVID-19.
- **Laboratory Mismanagement:** India has multiple laboratories with different biosafety levels (BSLs) set up across the country. Although new biosafety guidelines issued by the Department of Biotechnology (DBT) mention certification and validation for the higher-standard BSL-3 and BSL-4 labs, the country lacks accredited government or private agencies to certify and validate the lower-standard BSL-2 laboratories' compliance with safety rules.
- **Technology Misuse:** Disease-causing pathogens are abundantly available in nature. Technologies needed to manipulate them are becoming more easily accessible. Actors with nefarious designs could purposefully weaponize such technologies and naturally occurring pathogens. India is vulnerable to zoonotic diseases. Naturally occurring zoonotic pathogens can be manipulated in the lab to enhance their virulence, transmissibility, and/or resistance to therapeutic interventions. India shares porous borders with most of its neighboring states, the possibility of cross-border infections is another major biological threat.

## Impact of Biological Disaster

- **Loss of life:** Depending on the severity and transmissibility of the pathogen, death rates can vary greatly, potentially reaching significant proportions of the population. For instance **COVID-19** led to **7,019,704 deaths around the world.**
- **Mental health:** Fear, anxiety, depression, and trauma can be widespread during and after a biological disaster. This can lead to increased mental health problems and disruptions in social interactions.
- **Economic disruption:** Biological disasters have a detrimental impact on economic growth due to two primary factors.
  - **Financial Instability:** The growth of the global epidemic directly contributed to considerable confusion about instability in the financial and capital markets.
  - **Restricted Movement:** Countries start regulating human movement and transport to monitor the growth of the epidemic and significantly reduce economic activity.
  - **Impact on India:** As per the official data released by the Ministry of Statistics and Programme Implementation, the Indian economy contracted by 7.3% in the April-June quarter of 2021.
- **Strain on infrastructure:** Hospitals, public health systems, and emergency services may become overwhelmed by the surge in demand, leading to inadequate care and resource shortages.
- **Social unrest:** Fear, frustration, and economic hardship can contribute to social unrest and instability, including protests, riots, and violence. **The issues such as Migrant unrest, farm protests and blame game between religious communities in India exemplify this.**
- **Food insecurity:** Crop failures due to plant diseases or disruptions in agricultural production can lead to food shortages and malnutrition, particularly in vulnerable populations.

## Steps Taken by the Government

- **Diseases emerging from natural sources:** India has invested in a public health infrastructure and has



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various laws and guidelines that drive preparedness and response to naturally occurring disease outbreaks. **The National Centre for Disease Control** is under the administrative control of the Directorate General of Health Services, MoH&FW. It has various technical divisions and many specialized laboratories. The institute has three technical centres, viz. Centre for Epidemiology and Parasitic Diseases, Advanced Centre for HIV/ AIDS and Related Diseases, and Centre for Medical Entomology and Vector Management; and four technical divisions—Biochemistry and Biotechnology, Microbiology, Training and Malariology, and Zoonosis.

- **Diseases caused by Laboratory Mismanagement:** India has developed comprehensive biosafety guidelines to monitor the safety of biotechnological research.
- **Threats emerging from intentional sources**: India has no specific biosecurity policy or legislation but has a multiplicity of regulations that address threats emerging from different sources.
- **Various acts and policy initiatives taken by the government**
  - **The Epidemic Diseases Act, 1897:** A colonial-era law empowers state and central governments to control the spread of epidemic diseases. It allows inspection, regulation, and segregation of individuals suspected of infection, particularly during travel by railway.
  - **National Disaster Management Act, of 2005:** This act provides a legal framework for disaster management in the country, including epidemics. It establishes the National Disaster Management Authority (NDMA) and mandates the preparation of national and state-level disaster management plans.
  - **National Health Policy, 2017:** The National Health Policy outlines the government's vision to ensure the attainment of the highest possible level of health for all. It emphasizes the importance of preventing and controlling communicable diseases, including epidemics.
  - **National Centre for Disease Control (NCDC):** The NCDC plays a crucial role in disease surveillance, outbreak investigation, and control. It provides technical support to states and union territories in managing public health challenges, including epidemics.
  - **State Health Departments and District Surveillance Units:** Each state has its health department responsible for implementing disease control measures. District Surveillance Units work at the local level to monitor and control the spread of diseases.
  - **World Health Organization (WHO) Collaboration:** India collaborates with the WHO to align its epidemic preparedness and response strategies with international standards. This includes information exchange, technical assistance, and capacity building.

## Challenges in Mitigation

- **Infrastructure and policy issues:** India's response to the avian influenza, Nipah virus disease, and COVID-19 has exposed the country's public health infrastructure, **poor disease surveillance network, inadequate coordination between ministries to prevent zoonotic infections, absence of a national policy on biological disasters, and dismal investment in scientific research.** Rather than using the time between outbreaks to develop national guidelines to tackle infectious diseases, India mostly relies on ad hoc notifications and guidelines, along with World Health Organization (WHO) advisories during COVID-19.
- **Multiplicity of Organisations:** Although implementation of biosafety guidelines falls under the ambit of the Ministry of Science and Technology and MOEFCC, researchers often work in labs supported by the Indian Council of Medical Research (ICMR) and the Indian Council of Agricultural Research, which are research bodies set up under the Ministry of Health and Family Welfare (MOHFW) and the Ministry of Agriculture and Farmers' Welfare. **The multiplicity of organizations operating under different ministries makes it difficult to ensure implementation of biosafety guidelines across the country.**
- **Ministry of Statistics and Programme Implementation Resistance:** Poor patient adherence to antibiotic treatment, non therapeutic use of antibiotics to promote growth in farm animals, self-medication, and illegal over-the-counter access to antibiotics makes antibiotic resistance an emerging health threat that demands immediate policy attention.
- **Lack of Human Resources:** There is a shortage of medical and paramedical staff at the district and sub-district levels. There is also an acute shortage of public health specialists, epidemiologists, clinical microbiologists and virologists.
- **Socioeconomic and Food Crises:** Biological hazards such as COVID-19 not only flourish, but they also exacerbate socioeconomic and food crises. This underscores the systemic nature of contemporary crises, where the most vulnerable are affected the most.
- **Social Distancing:** Implementing social distancing measures for instance during COVID-19 lead to reduced economic activity and social interaction, neglect of vulnerable populations, and psychological damage.
- **Policy constraints**: Some scientific experts emphasized that the sudden ban on plastic in India in 2018 has

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made it difficult to use autoclavable plastic bags to dispose of laboratory waste. This has complicated the implementation of the proper disinfection protocol to dispose of biomedical waste, posing a serious biosafety hazard.

## Way Forward

- **Specific agency for Biological Disasters:** As the spread of infectious diseases is a long-term, continuous, and evolving threat, India may need an agency specifically responsible for preventing and managing biological threats. India could consider investing in an agency that can coordinate policy responses for any biological emergency. A full-time **Office of Biological Threats Preparedness and Response (BTPR)** under the National Disaster Management Authority (NDMA) is being suggested as an alternative.
- **Legislation:** The Epidemic Diseases Act was enacted in 1897 and needs to be repealed. This Act does not provide any power to the centre to intervene in biological emergencies. It has to be **substituted by an Act which takes care of the prevailing and foreseeable public health needs including emergencies such as BT attacks and use of biological weapons by an adversary, cross-border issues**, and international spread of diseases. It should give enough powers to the central and state governments and local authorities to act with impunity, notify affected areas, restrict movement or quarantine the affected area, enter any premises to take samples of suspected materials and seal them. The Act should also establish controls over biological sample transfer, biosecurity and biosafety of materials/laboratories.
- **Benefiting from Past Experiences:** The handling of COVID-19, the first biological disaster which affected the entire nation, offers important lessons for managing future disasters. The National Clinical Management Protocol provided comprehensive guidelines for case management. Emphasis on personal health and hygiene, enforcement of the Disaster Management Act, and use of indigenous knowledge were key strategies. The formation of Empowered Groups for decision-making proved effective. These strategies could be tailored for future biological disasters.
- **Fostering Resilience:** It is the key to develop a comprehensive, coordinated, proactive, and technologically advanced strategy for managing biological disasters. This includes fostering a culture of prevention and mitigation, for instance **Nature-Based Disaster Risk Reduction**; this initiative promotes livelihoods through nature-based disaster risk reduction, significantly reducing the risk of disaster and building safer, more resilient communities.

### NDMA Guidelines on Biological Disasters

The Indian government has released several guidelines to enhance preparedness and manage various types of biological disasters. These include:

- **Medical Preparedness and Mass Casualty Management (2007):** Focuses on all-hazard medical readiness, with emphasis on CBRN casualties.
- **Guidelines on Chemical (Industrial) Disasters (2007):** Concentrates on managing chemical industrial disasters and coordinated responses to resulting casualties.
- **Guidelines on Management of Biological Disasters (2008):** Focuses on preventing, preparing for, and managing epidemics, pandemics, and bioterrorism incidents.
- **Guidelines on Management of Chemical (Terrorism) Disasters (2009):** Addresses prevention, preparedness, and capacity development, with a focus on strengthening resources and services.
- **Guidelines on Psycho-social Support and Mental Health Services (PSSMHS):** Addresses post-disaster psychosocial and mental health issues with interventions like psycho-social first aid and coordinated referral mechanisms.

## CONCLUSION

Anthropogenic disasters, stemming from human activities, present significant challenges to both the environment and human well-being. To mitigate these disasters effectively, a multi-faceted approach is crucial. Continuous investment in research and education is crucial for better understanding of the causes and impacts of anthropogenic disasters and for devising innovative solutions. By embracing above given strategies, it is possible to reduce the frequency and severity of anthropogenic disasters, fostering a more sustainable and resilient future for both people and the planet.

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# Relief, Recovery and Rehabilitation

5

## INTRODUCTION

In the previous chapters, we explored the crucial role of disaster mitigation in disaster management. We learned how proactive measures, from strengthening infrastructure to fostering community preparedness, can pre-empt disaster's destructive grasp. However, even the most comprehensive mitigation strategies cannot fully eliminate the possibility of catastrophe. When disasters strike, a different phase of the cycle comes into play - the critical stage of disaster relief, recovery, and reconstruction. The catastrophic aftermath of disasters presents a complex challenge for disaster management. This chapter delves into the intricate interplay of these phases, navigating the transition from emergency response to long-term resilience building.

## FIRST RESPONDERS

First responders in disaster management are the **initial individuals or organisations arriving at the scene of an emergency or disaster.** They play a critical role in providing immediate assistance, including search and rescue, medical care, and evacuation. These frontline workers include **paramedics, firefighters, police officers, and other emergency personnel.** Their prompt actions aim to mitigate harm, save lives, and stabilise the situation during the early stages of a crisis, serving as the first line of defence before additional support and resources are mobilised.

**Fig. 5.1:** Emergency Responders

### The Rationale of First Response

- **Saving lives and reducing suffering:** They provide immediate medical assistance, rescue trapped individuals, and initiate vital procedures like securing collapsed structures or preventing further harm. For example, During the **Kerala floods in 2018**, a team of Navy divers risked their lives to rescue a pregnant woman and her family trapped in a submerged house in Aluva.
- **Minimising damage and ensuring safety:** They secure unsafe areas, assess potential hazards, and initiate measures to prevent further damage or secondary disasters. This can involve tasks like extinguishing fires, controlling floods, or securing hazardous materials. Their swift intervention can significantly reduce the long-term costs and consequences of a disaster.
- **Providing stability and hope:** Their presence offers reassurance, guidance, and a sense of order amidst the disruption. They provide crucial information, coordinate rescue efforts, and facilitate communication channels. This fosters a sense of security and paves the way for organised recovery efforts. After the 2001 **Gujarat earthquake,** NDRF (National Disaster Response Force) teams worked tirelessly for days to pull survivors from collapsed buildings. Their rescue efforts saved hundreds of lives and brought hope to countless families amidst the tragedy.
- **Fostering trust and collaboration:** First responders often form the bridge between affected communities and official response agencies. Their direct interaction with survivors builds trust and understanding, enabling effective communication and collaboration during challenging times. They play a crucial role in ensuring that the needs of the affected population are heard and addressed throughout the recovery process.

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### People As First Responders

People serve as crucial first responders in disasters, emphasizing the need for empowering communities through basic knowledge and early socialization in disaster management. As the primary individuals affected, their preparedness is vital, prompting initiatives like incorporating disaster education into school curricula. Proactive information dissemination, collaborative efforts with volunteer organizations, and community-level planning further enhances the role of people in minimizing the impact of disasters. **Empowering communities for disaster response involves volunteer training, proactive information dissemination, disaster preparedness tips and pre-planning for emergencies.**

### Role of Government in First Response

In disasters, governments are the ultimate first responders. They **act like a command centre, coordinating the rescue, mobilizing supplies, and informing the public.** They ensure speedy resource delivery, infrastructure repair, and debris

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removal, all while prioritizing safety and communication. Their long-term focus is on damage assessment, recovery plans, and rebuilding communities, making them crucial for minimizing disaster impact and supporting affected populations.

### India as First Responder

- **India has emerged as the first responder** in Humanitarian Assistance and Disaster Relief (HADR) efforts at the global level.
- Through strengthening multilateral partnerships and engagement via regional mechanisms, improved interoperability, and faster response it has been playing an important role in providing HADR across the world.
- Prominent examples
  - **Operation Maitri,** rescue operations during earthquake in Nepal.
  - Assistance to Sri Lanka in 2016 during Cyclone Roanu, the earthquake in Indonesia in 2018, flooding in Madagascar in January 2020 and the supply of vaccines during the COVID-19 pandemic.
  - **Operation Dost** following the recent earthquake in Turkey.

**IGNITE YOUR MIND**

In 2015, Operation Maitri was launched for responding to Nepal's earthquake. Do you think sustainable practices in recovery amplify a shared responsibility, not just within national boundaries but across the broader spectrum of our interconnected world?

## DISASTER MANAGER

A disaster manager, often a specialist in public health or engineering, coordinates pre-, during, and post-disaster activities. **In India, the District Collector serves as a disaster manager at the district level.** A disaster manager must possess essential managerial skills to handle chaotic situations effectively.

### Role and Functions

Disaster management includes **pre-disaster planning, preparedness, response, information management, and conflict resolution.** Applying management principles is essential because disasters disrupt economies and cause severe consequences. Managerial concepts help address critical issues and find solutions amid challenging circumstances.

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| Traditional Approach | Contemporary Approach |
|---|---|
| Centralised decision-making | Decentralised and participative decision-making |
| Emphasis on relief | Pre-and Post-disaster activities linked to development goals |
| Quantity of Relief | Quantity and quality of services |
| Reactive approach | Proactive approach |

Disaster management involves **identifying and assessing threats, reducing risks, and managing losses.** Post-disaster efforts focus on response, relief, and rehabilitation. Effective resource management involves finances, personnel, logistics, and information. Innovative approaches empower communities to invest in preventive measures.

### Incident Command System: A Managerial Tool

The Incident Command System (ICS) provides a structured management approach for coordinating crisis-related activities and directing efforts toward stabilizing incidents while safeguarding life, property, and the environment. Originally developed in the 1970s in response to wildfires in Southern California, the ICS model has been adopted by many countries worldwide.

**Fig 5.2:** Main Dimension of Incident Command System



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## EMERGENCY OPERATIONS CENTRE (EOC)

An EOC serves as the **central hub for coordinating an organisation's response and recovery efforts during emergencies.** Also known as command centres, they handle resource distribution, communication, and coordination for disasters with multiple impacts or large complexities. Unlike incident command posts, **EOCs are situated away from disaster sites, typically near government offices.** EOCs prioritise resource distribution, facilitate off-site concerns, and ensure effective communication between various responding agencies. Originally a civil defence concept, EOCs are now crucial for both wartime and peacetime activities, especially in large-scale disaster responses.

### Non-Disaster Time Activities of The EOC

During non-disaster periods, EOC undertakes **crucial activities to enhance its effectiveness, such as operationalizing Disaster Management Plans, updating plans, and maintaining inventories.** The EOC Activation Procedure involves shifting to emergency mode and notifying relevant ministries and departments. Rapid Assessment and Quick Response Teams are deployed promptly for efficient disaster management. Reporting Systems involve community members informing local authorities, and initiating the EOC activation process.

## SEARCH AND RESCUE (SAR)

Search and rescue is the **immediate post-disaster effort involving local volunteers,** organisations, and emergency agencies. Local volunteers conduct Light Search and Rescue, identifying and helping individuals in lightly damaged buildings. If needed, specialized emergency agencies or Defense Forces may assist, aiming to save the maximum number of victims in a systematic and organized manner amid post-disaster chaos.

### Phases of SAR

Search and rescue (SAR) is the crucial process of locating and aiding disaster victims trapped or isolated after an incident. Local individuals familiar with the terrain often play a key role in SAR, supported by sniffer dogs, heavy machinery, and specialized equipment. Floods and cyclones necessitate the use of boats and helicopters for systematic SAR operations. Following SAR, essential measures are implemented to provide relief to evacuees.

- Medical Aid.
- Water and food.
- Shelter.
- Temporary subsistence supplies.
- Health and sanitation.
- Information.
- Security.

**Search and Rescue Operations (SAR) Stages**

| | |
|---|---|
| **First Stage** | ❑ The initial phase involves locating and rescuing individuals with injuries visible in the affected area.<br>❑ Example: In the case of floods in Sikkim in the year 2023, Hundreds of search and rescue personnel were deployed across the state and it was estimated that around 3000 tourists were stranded in different parts of the state. |
| **Second Stage** | ❑ Subsequently, efforts focus on rescuing individuals who can be contacted but are in inaccessible locations, such as under rubble or in elevated positions.<br>❑ Example: In the case of floods in Sikkim in the year 2023, The Indian Air Force started rescue and relief operations in the Himalayan state, airlifting the first batch of stranded tourists from Lachen to Mangan in North Sikkim. |
| **Third Stage** | ❑ The third stage comprises systematically searching areas where survivors are expected to be trapped, known as 'likely survival points'. |
| **Final Stage** | ❑ The final stage involves clearing debris obstructing the path to these probable survival points.<br>❑ Example: In the collapse of the Silkyara tunnel in Uttarakhand, the rescue team led by the NDRF and the SDRF made a final passage to rescue 41 trapped workers. |

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### Behavioural Requirements of Search, Rescue and Evacuation

- **Qualities of a Good Rescuer:** Proficient rescuers need physical fitness, training, and experience. Incompetent rescuers can hinder operations and worsen situations, risking harm to those in need. Essential attributes for rescuers include **technical proficiency, practical reasoning, a sense of direction, improvisation skills, sound judgment, and both physical and mental fitness.**
- **Evacuation:** Evacuation relocates individuals from danger to safety before, during, or after an emergency like an earthquake or fire. Proper methods prevent fatalities, emphasizing brief, safe exit routes, and avoiding areas increasing vulnerability for occupants.
- **General Precautions while Carrying out Search and Rescue:** In Search and Rescue (SAR), prioritizing rescuer safety is crucial. Wear necessary protective equipment, work in pairs for mutual support, identify alternative escape routes, and follow guidelines. Thorough searches



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in various areas, including toilets, storerooms, and lifts. Ensure rescuer's safety during SAR missions.

**INCOIS Develops SARAT-1 For Search & Operations on Sea**

The Airports Authority of India (AAI) and the Indian Coast Guard collaborated with the Indian National Centre for Ocean Information Services (INCOIS) to develop an application to aid in locating missing aircraft at sea. The Search And Rescue Aid Tool-Integrated (SARAT-I) uses a statistical approach to compute the probability map of the aircraft's descent into the sea, using a methodology approved by international agencies. The application eliminates human error in computation, saves time for rescue operations, and potentially reduces expenditure.

## CHALLENGES IN DISASTER OPERATIONS

Navigating disaster operations presents multifaceted challenges, encompassing coordination hurdles, resource limitations, and unpredictable scenarios. Addressing these complexities demands strategic planning, efficient communication, and adaptive responses to safeguard lives, minimize damage, and facilitate swift recovery. Some of the main challenges are as follows:

- **Resource Limitations:** Limited availability of funds, personnel, and equipment can hinder effective disaster response efforts.
- **Logistical Complexities:** Managing and transporting resources to affected areas, especially in challenging terrains or during adverse weather conditions, poses logistical challenges.
- **Coordination Issues:** Coordinating efforts among various agencies, organizations, and government bodies may be complex, leading to potential gaps in response.
- **Communication Breakdowns:** Disruptions in communication networks can impede the flow of vital information, hindering coordination and decision-making.
- **Community Engagement:** Ensuring active community participation and cooperation during disaster response can be challenging, impacting the effectiveness of relief efforts.
- **Rapidly Changing Situations:** Dynamic and unpredictable disaster scenarios require quick adaptation and decision-making, adding complexity to operations.
- **Risk of Secondary Hazards:** The potential for secondary hazards, such as aftershocks or disease outbreaks, complicates response efforts and necessitates additional preparedness.
- **Evacuation Challenges:** Safely evacuating and providing shelter for large populations promptly can be logistically demanding and resource-intensive.
- **Information Management:** Handling and disseminating accurate information in real-time is crucial; misinformation or lack of information can hinder response efforts.

## WAY FORWARD

- **Training and Capacity Building:** To improve disaster operations, we must train more helpers in every community, making sure they know what to do during floods, storms, or other emergencies. It's crucial to have plans ready, with clear instructions and safe places to go.
- **Support from the Community:** Communities need regular practice to be ready, and governments should give them the right tools and support.
- **Proper Communication:** Better communication and sharing of helpful information quickly can save lives. We must also learn from past disasters to do things better next time. By working together, preparing well, and using what we've learned, we can protect more people and recover faster.

**IGNITE YOUR MIND**

As technology advances and the nature of disasters evolves, what does the future hold for Search And Rescue? Can you think of the pros and Cons of introducing such measures?

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- **Better Use of Social Media:** After the Kerala flood in 2018, Social Media came to the rescue. Charity organizations such as World Vision, which has been operating in India since the 1950s, used its website, to collect donations for relief kits. More initiatives can be used.
- **Use of Drones:** "Drones Tech Lab", a start-up at IIT Guwahati used drones to reach out to the people trapped in the floodwaters in lower Assam, with relief. It can be replicated in another disaster-hit area also.

After the **First Response comes Recovery, rehabilitation, and reconstruction (RRR)**. RRR forms the crucial bridge between the immediate aftermath of a disaster and a resilient future. It's the long-term process of healing communities, restoring livelihoods, and rebuilding infrastructure. Imagine a disaster zone as a broken vase. Recovery is like gathering the pieces, rehabilitation is like mending them together, and reconstruction is like giving the vase a new life, perhaps even stronger and more beautiful than before. It is a complex and multifaceted process, requiring collaboration between governments, NGOs, communities, and individuals. It involves restoring essential services like electricity and water, reviving local economies, providing psychosocial support, and rebuilding homes, schools, and hospitals.



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# RECOVERY

## Nature of Recovery With Regard to Different Disasters

- **Recovering from Large-scale Disasters:** Floods, earthquakes, and cyclones cause extensive damage, posing significant recovery challenges. The nature of recovery in such situations is inherently complex and demanding. These catastrophic events disrupt communities, infrastructure, and essential services, necessitating a focused and comprehensive recovery strategy.
- **Recovery from Draught:** In events like droughts, where infrastructure remains intact, rehabilitation mainly focuses on restoring livelihoods within regular development programs.
- **Biological Disaster Recovery:** In the case of a disease outbreak like COVID-19 (2020), swift implementation of quarantine measures and containment zones aid in restricting the spread of the biological agent.
- **Recovery from Industrial Disasters or Chemical Disasters:** Recovery from industrial disasters involves rapid decontamination of affected areas, soil remediation is essential for restoring the environment along with potential victim counselling as it is done during COVID-19 through measures such as isolation and Quarantine.
  - **Industrial disasters**, like the 'Bhopal Gas Tragedy'(1984), may span a generation in rehabilitation efforts, addressing livelihoods, and social and psychological needs.
- **Recovery from Landslides and Avalanches:** Recovering from events like landslides and avalanches closely resembles earthquake recovery but operates on a smaller scale. The process involves overcoming challenges related to identifying safer sites in proximity to affected areas. The rehabilitation efforts in such locations are inherently localised, demanding a tailored approach to address the unique nuances of each impacted area.

## DISASTER ASSESSMENT FOR BETTER RECOVERY

The first step after stabilising the situation by providing sufficient relief is to assess the damage.

Disaster assessment is a systematic procedure aimed at evaluating the impact, extent, and severity of a disaster on affected regions and populations.

- **Objective Of Assessment:** The primary objective of disaster assessment is to acquire precise and timely information to steer response and recovery initiatives.
- **Process of Assessment:** This process entails the systematic collection and analysis of data to comprehend the scale of damage, ascertain immediate requirements, and prioritize interventions.
- **Comprehensive Assessment Teams:** The assessment is most effectively executed through diverse teams encompassing various disciplines. These teams delve into all dimensions of damage—social, economic, and psychological—through active collaboration with the local community.

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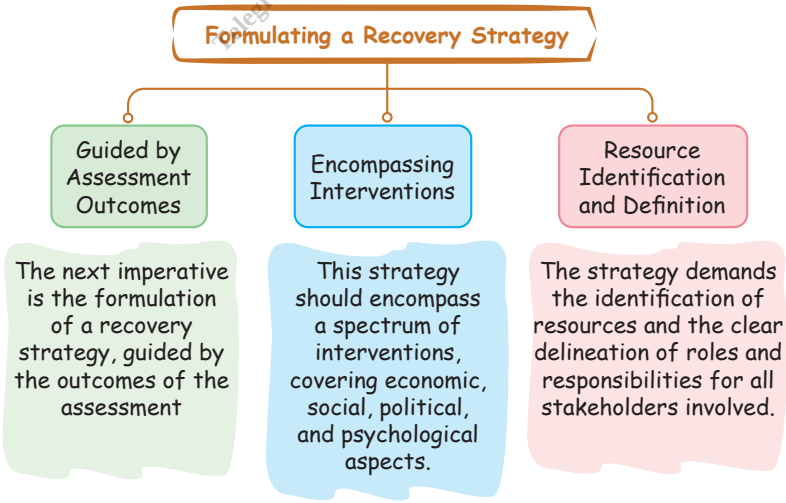


**Fig 5.3:** Formulating a Recovery Strategy

## Effective Coordination in Post-Disaster Recovery

Following any major disaster, a number of players arrive on the scene and as already stated, ensuring proper coordination amongst them thus becomes very important. The following strategy should be followed for better coordination.

- **Coordination Among Stakeholders:** In the aftermath of significant disasters, various entities, including government agencies, local bodies, international organisations and voluntary groups, engage in recovery efforts. The absence of proper coordination among these stakeholders can result in operational imbalances,



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redundant interventions, gaps in service delivery and the inefficient use of resources. For example, after the 2018 Kerala Floods, good coordination helped a lot, but during the Haiti Earthquake in 2010, there wasn't enough coordination, causing problems.

- **Establishing a Coordination Center:** To streamline relief and rehabilitation activities carried out by multiple organizations, the administration must establish a coordination centre for voluntary organizations. This ensures that interventions are distributed evenly and not concentrated in specific areas. For example, establishing a coordination centre helps groups like National Disaster Management Authority, State Disaster Management Authority, and District Disaster Management Authority work together better.

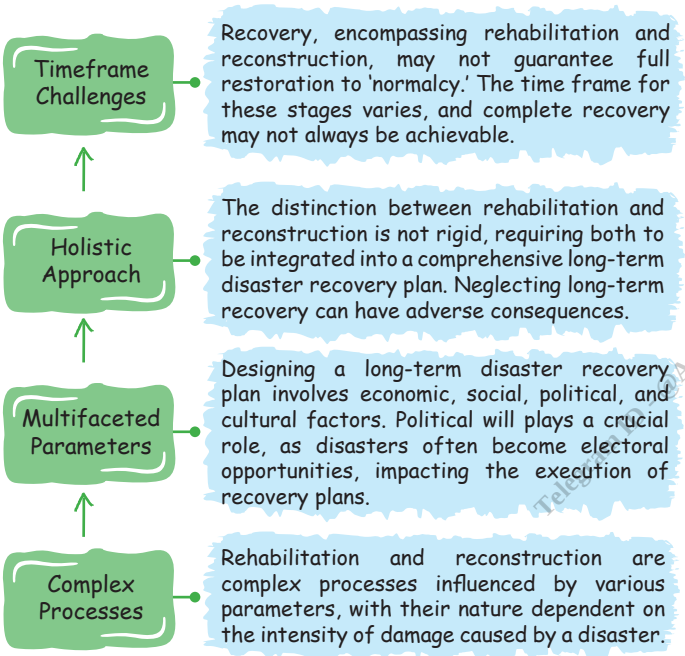


**Fig 5.4:** Challenges and Complexity in Recovery

- **Proactive Risk Reduction Measures:** Recognizing the post-disaster recovery phase as a **'window of opportunity,'** it is essential to integrate disaster risk reduction measures into the redevelopment process. This proactive approach ensures a more resilient and sustainable recovery. For example, measures like Build Back Better.

## SUSTAINABILITY IN THE RECOVERY PROCESS

Normally, it is seen that the recovery efforts tend to taper off with the passage of time. The sustainability component in the recovery process therefore is important. This could be achieved by capacity-building of community and awareness generation and preparing local crisis management plans.

### Challenges for Sustainable Recovery

- **Reduced Efforts Over Time:** Recovery work tends to slow down as time passes, making it harder for affected areas to fully bounce back. After the floods in Uttarakhand in 2013, recovery efforts slowed, causing prolonged difficulties for the affected communities.
- **Limited Community Involvement:** Making recovery efforts last requires active participation from communities, which is sometimes overlooked. The Bhuj earthquake in 2001 showed that involving communities was crucial for successful rebuilding.
- **Issues in Distributing Aid:** Ensuring that aid reaches the right people and funds are used well is essential. The Kerala floods in 2018 revealed problems in this area, impacting the efficient distribution of relief.
- **Inadequate Systems for Addressing Concerns:** Dealing with problems during relief and recovery can be challenging without effective systems for addressing concerns. Events like the Bhopal gas tragedy in 1984 highlighted the need for prompt mechanisms to handle issues.

### Strategies for Sustainable Recovery

- **Empowering Communities:** Focus on building capabilities within communities. Increase awareness and involve the community in creating local crisis management plans. The recovery process after the Kerala floods in 2018 showed that empowering communities is effective for sustainable rebuilding.
- **Ensuring Accountability:** Establish a strong accountability system during relief and recovery. Make sure funds are used efficiently and address distribution problems. The recovery from the Bhuj earthquake demonstrated the importance of accountability for successful relief efforts.
- **Evaluation for Improvement:** Conduct a thorough evaluation after the recovery phase. Assess strengths and weaknesses in the disaster management process. Events like the Uttarakhand floods highlight the need for evaluations to enhance future disaster responses.
- **Swift Audit for Financial Oversight:** Include a quick audit of expenditures in the evaluation process. Ensure transparency in finances and optimal resource use. The aftermath of the Bhopal gas tragedy emphasised the need for swift financial oversight to prevent fund misuse and ensure proper resource utilisation.



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### Principles Guiding Post-Recovery

- Mainstreaming disaster risk reduction in the recovery and development process.
- Improving coordination.
- Promoting participatory approaches and decentralising planning and programming for recovery.
- Enhancing safety standards and integrating risk reduction in reconstruction and development.
- Improving the living conditions of the affected communities and sectors.
- Building local and national capacities for increased resilience, risk management and sustainable development.
- Taking advantage of ongoing initiatives, Gender sensibility.
- Demonstrative effects.
- Monitoring, evaluation and learning.

## REHABILITATION AND RECONSTRUCTION

The transitional stage, situated between **disaster response and overall development,** demands vital interlinkages. Systematic planning and implementation of a long-term recovery program are crucial for effective disaster management.

### Rehabilitation: Connecting Immediate Needs and Normalcy

- **Definition and Focus:** Rehabilitation involves restoring local services to fulfil immediate needs, aiming for a systematic return to pre-disaster status. It focuses on resuming basic services, aiding self-help efforts, repairing physical damage, reviving economic activities, and supporting the well-being of survivors.
- **Transitional Phase:** Rehabilitation is considered a transitional phase between immediate relief and long-term development, rehabilitation enables affected populations to return to more or less normal patterns of life. This phase involves crucial aspects such as medical assistance and food support. For example, after the devastating Kerala floods in 2018, the transitional rehabilitation phase played a pivotal role.

### Reconstruction: Long-Term Development Assistance

- **Definition and Scope:** Reconstruction represents long-term development assistance, helping affected areas rebuild lives and meet present and future needs. It considers reducing future disaster risks and may involve replacing temporary arrangements established during emergency response.
- **Integration with Development Plans:** Reconstruction must be fully integrated into long-term developmental plans, considering future disaster risks and incorporating measures to reduce them.
- **Example:** Rehabilitation of power lines aims for rapid restoration of essential services, while reconstruction aims to rebuild the rehabilitated system to a higher or safer standard, reducing future risks.

Thus, economic, social, and cultural factors are integral to recovery planning, shaping the rehabilitation and reconstruction processes. The political environment post-disaster needs consideration, as politics, will significantly influence the execution of recovery plans, with politicians leveraging recovery for electoral gains.

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### TYPES OF REHABILITATION

**Fig 5.5:** Types of Rehabilitation

### Physical Rehabilitation: Rebuilding Infrastructure

- **Integral Rehabilitation Aspect:** The vital aspect of physical rehabilitation involves the reconstruction of vital infrastructure, including houses, buildings, railways, roads, communication networks, water supply, and electricity. This encompasses both short-term and long-term strategies, as exemplified during the Nepal Earthquake of 2015.



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### Social Rehabilitation: Community Support Systems

- This process focuses on rebuilding social structures, fostering community cohesion, and providing support systems to help individuals recover and reintegrate into society.
- For example, during the Gujarat **Earthquake in 2001,** The **"Kutch Mahila Vikas Sangathan (KMVS)"** mobilised its network of women's groups to provide safe spaces for women and children, address gender-based violence concerns, and offer trauma counselling. They also helped women revive their traditional handicraft livelihoods through economic rehabilitation programs.

### Psychological Rehabilitation: Healing Emotional Scars

- Psychological rehabilitation seeks to restore mental well-being following the trauma or mental health issues through counselling, support, and skill development for improved coping and resilience.
- For example, during the **Kashmir Floods 2014,** the state government deployed Psychosocial teams from the National Institute of Mental Health and Neuro Sciences (NIMHANS) Bangalore, for conducting Psychosocial Need Assessment.

## GUIDING PRINCIPLES OF REHABILITATION AND RECONSTRUCTION

- **Communities as Diverse Entities:** A comprehensive rehabilitation plan must recognize the heterogeneity within affected communities. Varied needs emerge across different groups, from farmers to traders or professionals. Children, women, and the elderly have unique requirements. Prioritising diverse needs is crucial for effective recovery.
- **Balancing Economic, Social, and Psychological Aspects:** Harmonising economic, social, and psychological needs is intricate, given their divergence among different community segments. Economic compensation, though vital, may not assuage the psychological impact. Successful recovery plans strike a delicate equilibrium, acknowledging and addressing diverse requirements.
- **Systematic Damage Assessment:** A systematic approach to damage assessment, incorporating sample surveys and leveraging modern technology, is fundamental. Aerial photography, feasibility studies, and risk management play pivotal roles in understanding, quantifying, and mitigating the impacts. Incorporating these assessments into the recovery plan ensures a well-informed and targeted approach.
- **Disaster Financing:** Governments deploy specific schemes for disaster management financing, including the Calamity Relief Fund (CRF), National Calamity Contingency Fund, Prime Minister's National Relief Fund, and Member of Parliament Local Area District Scheme (MPLADS). Insurance schemes and developmental programs like Swarnajayanti Gram Swarozgar Yojna contribute to resource generation.
- **International Cooperation:** UN agencies, including WHO, UNICEF, UNESCO, WFP, ILO, UNFPA, and international financial institutions like IMF and World Bank, can provide legitimacy and financial support for disaster recovery projects. Incorporating their assistance enhances the overall recovery process.
- **Building Resilient Communities:** Effective rehabilitation must consider the psychological aspects of affected communities. Strategies include community participation, education and training, stress management, and positive media engagement. Resilience-building measures like creating Village Task Forces and involving local organizations should be integrated into recovery plans.
- **Respecting Traditional Wisdom:** Traditional practices for disaster resilience, like those related to water conservation and earthquake-resistant structures, should be preserved. A balanced approach, integrating traditional wisdom with modern technology, is essential for sustainable recovery.
- **Disseminating Good Practices:** Advancements in Information and Communication Technologies (ICT) play a vital role in effective disaster management. Replicating successful case studies and incorporating grassroots experiences into developmental policies can strengthen recovery efforts. Education and training are key components in transferring good practices to threatened communities.

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### Case Studies Regarding Disaster Reconstruction

- **Christchurch, New Zealand Earthquakes (2010-2011):** Following a series of devastating earthquakes, Christchurch embarked on a comprehensive reconstruction project focused on resilience and sustainability.
  - **"Rebuild Stronger" policy:** Emphasised earthquake-resistant building codes and sustainable infrastructure development.
  - **Community-driven planning:** Residents actively participated in shaping the city's new layout and prioritising public spaces.
  - **Creative urban design:** Innovative architectural projects and revitalised cultural initiatives fostered a sense of identity and community spirit.
- **Tohoku earthquake and tsunami, Japan (2011):** Post-disaster reconstruction in Japan focused on disaster preparedness and innovation.
  - **"Seawalls and elevated infrastructure"** to mitigate future tsunami risks.
  - Smart grid technology and resilient housing designs to improve disaster response and preparedness.
  - Revitalization of coastal communities through economic development and cultural preservation efforts.



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## Interlinkages Between Disaster Recovery and Development

Efficient and effective post-disaster development and recovery can help to reduce the devastation inflicted on humanity and can prevent poor communities from falling into cyclical poverty. Recovery and reconstruction, through their phases, provide the opportunity to rebuild beyond pre-disaster states for safer, more sustainable and resilient communities.

### Building Back Better

- **What is the BBB Approach?:** Building Back Better (BBB) is an approach to post-disaster recovery that reduces vulnerability to future disasters and builds community resilience to address physical, social, environmental, and economic vulnerabilities and shocks.
- **Sustainable Safety**: Risk reduction now permeates development activities. Yet BBB, distinct from development, does not focus on rectifying a country's development deficits but on ensuring the result of recovery is sustainable safety for more resilient communities.
- **BBB in Infrastructure Reconstruction**: BBB offers the opportunity to rebuild stronger, safer, and more disaster-resilient infrastructure and systems. For example:
  - **Land-use planning** regulations, which curtail reconstruction in high-risk areas.
  - Reconstructing improved **hazard-control infrastructure**, such as **flood embankments.**

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Gandhi dreamt of a nation awakened, self-sufficient and strong. Can our disaster response embody this dream? Are we simply sleepwalking through recovery, patching up wounds without addressing the deeper vulnerabilities? Can you think of a few measures which can be taken to make this process more inclusive and empathetic?

- **Upgraded Technology:** Replacing damaged assets with context-sensitive, technologically updated alternatives. For example, modernizing damaged telecommunications equipment to keep up with technological advances.
- **Meeting Community Demands**: Using recovery as an opportunity to right size infrastructure to better meet community needs. For example, reconstructing hospitals with an adequate number of beds.

## INDIAN LESSONS IN POST-DISASTER RECOVERY: EXPERIENCES AND INSIGHTS

In the last two decades, India has encountered various types of disasters, both natural and human-induced. The following incidents highlight some notable experiences in post-disaster recovery, rehabilitation, and reconstruction efforts. These experiences serve as valuable lessons for the country's overall recovery process, offering insights to guide future responders and aiding in the implementation of corrective measures.

## Dam Failures In India

The occurrence of dam failures in India has prompted a reevaluation of dam safety measures, leading to important lessons learned in post-disaster recovery.

### Recent Dam Failure Incidents in India

- **Teesta III Dam Failure (Sikkim, 2023):** In October 2023, the Teesta III Dam in Sikkim experienced a critical failure, resulting in widespread flooding and loss of life. Despite occurring outside the specified timeframe, this incident serves as a poignant reminder of the inherent dangers associated with dam failures. Presently, investigations are underway to determine the root cause of the failure.
- **Lakshmi Barrage Collapse (Telangana, 2023):** In October 2023, a segment of the Lakshmi Barrage on the Godavari River in Telangana collapsed. Fortunately, no casualties were reported. This incident, however, prompted concerns regarding the safety of ageing infrastructure and emphasized the imperative need for meticulous maintenance practices.
- **Bharudpura Dam Seepage (Madhya Pradesh, 2022):** In August 2022, the recently constructed Bharudpura Dam in Madhya Pradesh faced a notable challenge as significant seepage and erosion occurred shortly after its initial filling. This occurrence underscored the critical importance of comprehensive safety assessments before the commissioning of new dams.

### Indian Lessons for Post-Disaster Recovery

- **Adaptive Management:** Advocates for adaptive management practices, allowing adjustments in dam operations and maintenance based on changing conditions.
- **Collaboration Across Disciplines:** Emphasizes the importance of interdisciplinary collaboration among geologists, hydrologists, engineers, and local communities to address multifaceted dam safety challenges.
- **Learning from Failures:** Encourages a proactive approach to learn from past dam failures, influencing engineering practices, risk assessments, and regulations to prevent similar incidents.



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- **Maintenance as a Crucial Element:** Highlights the need for consistent maintenance to prevent deterioration of dam structures and reduce the risk of failure.
- **Comprehensive Risk Assessment:** Advocates for accurate risk assessments that consider potential consequences to ensure proactive dam safety.
- **Seismic Design and Retrofitting:** Underscores the importance of considering seismic factors in dam design and retrofitting, especially in earthquake-prone regions.
- **Regulatory Oversight and Community Awareness:** Highlights the critical role of regulatory oversight in enforcing safety standards and educating downstream communities about potential risks.
- **Emergency Preparedness:** Stresses the necessity of well-structured emergency response plans and communication systems to mitigate the impact of dam failures.

## Glacial Lake Outburst Flood (GLOF) In Sikkim (October 2023)

The sudden Glacial Lake Outburst Flood (GLOF) in Sikkim, India, in October 2023, triggered by the breaching of South Lhonak Lake, brought devastation to the region. Lives were lost, infrastructure damaged, and communities displaced. However, amidst the tragedy, valuable lessons emerged in India's response and recovery efforts, offering insights for future disaster management.

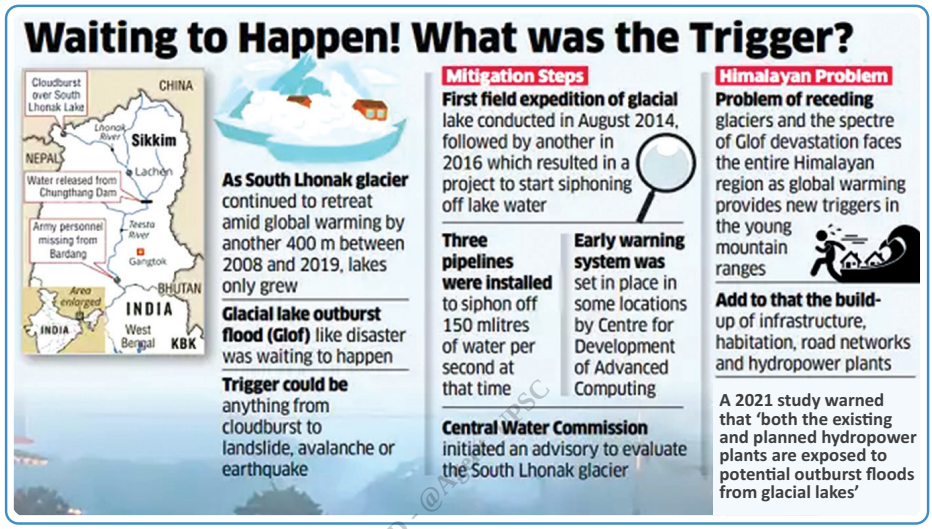


**Fig 5.6:** Glacial Lake Outburst Flood (GLOF) In Sikkim (October 2023)

### Immediate Response and Relief

- **Swift Evacuation and Relief:** The Indian Navy, Air Force, National Disaster Response Force (NDRF), and local authorities quickly led rescue efforts, evacuating people and supplying essential items. This swift response minimized casualties and reduced immediate suffering.
- **Community strength:** Local communities showed strong resilience, working with authorities and NGOs for rescue efforts and supporting each other during the initial response.
- **Effective coordination:** Collaboration among local authorities, the National Disaster Response Force (NDRF), and NGOs ensured efficient resource distribution. This coordinated approach prevented further hardship and aided initial recovery.

### Long-Term Reconstruction and Rehabilitation

- **Infrastructure rebuilding:** Efforts shifted toward reconstructing damaged infrastructure like roads, bridges, and irrigation systems, crucial for reviving livelihoods.
- **Environmental restoration:** Recognizing the region's ecological fragility, initiatives focused on slope stabilization, afforestation, and glacier monitoring to prevent future disasters and promote long-term environmental sustainability.
- **Community involvement:** Post-disaster reconstruction prioritized community participation, incorporating local knowledge into rebuilding plans. This inclusive approach ensured sustainable development.

### Key Takeaways

- **Disaster preparedness:** Sikkim's experience highlights the importance of robust disaster preparedness, including tailored early warning systems and evacuation plans for glacial flood risks.
- **Building resilience:** Investments in infrastructure, environmental protection, and community preparedness significantly enhance regional resilience, reducing the impact of future disasters.
- **Holistic approach:** Effective post-disaster recovery requires a comprehensive strategy covering immediate relief, long-term reconstruction, and environmental restoration, with a focus on community participation and sustainability.



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## Joshimath's Land Sinking Crisis

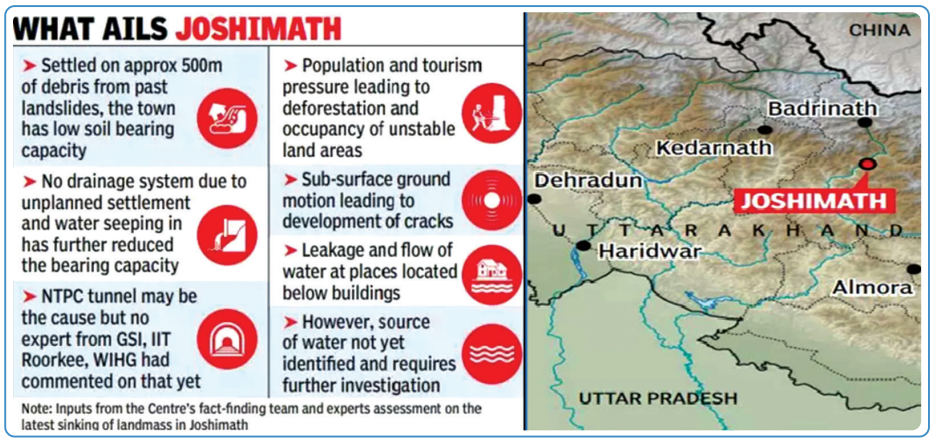


**Fig 5.7:** Joshimath's Land Sinking Crisis Explained

### What is Land Subsidence?

- Land subsidence can be defined as the **gradual settling or sudden sinking of the Earth's surface due to removal or displacement of subsurface earth materials.**
- The primary causes include:
  - Aquifer-system compaction associated with groundwater withdrawals
  - Drainage of organic soils
  - Underground mining
  - Natural compaction or collapse, such as with sinkholes or thawing permafrost

### What has happened in Joshimath?

- In Joshimath, situated in Uttarakhand, out of 4,500 buildings, 610 have developed huge cracks, making them unfit for habitation.
- The Incidents of land subsidence have been previously reported in Joshimath in the 1970s.
- The government then set up a panel under the chairmanship of **Garhwal Commissioner Mahesh Chandra Mishra who had submitted a report in 1978.**
- The commission recommended that major construction works should not be carried out in the city and the Niti and Mana valleys as these areas are situated on moraines
- Moraine is a mass of rocks, sediment, and soil transported and deposited by a glacier.

### Reasons for Land Subsidence in Joshimath

- Land subsidence in Joshimath is majorly due to the National Thermal Power Corporation's Tapovan Vishnugad Hydro Power Project
- There are two reasons for the Joshimath problem: -
  - The first is **rampant infrastructure development which is happening in a very fragile ecosystem like the Himalayas** and this is happening without much of a planning process in a way where we are able to protect the environment.
  - Secondly, climate change is a force multiplier. The way climate change is exhibited in some of the hilly states of India is unparalleled. For example, 2021 and 2022 have been years of disaster for Uttarakhand.

### Measures Towards Recovery and Reconstruction

- **Immediate Relief:** Families have been moved to safe locations in the town. As nearly 4,000 people were evacuated due to deep cracks in structures, ongoing investigations aim to uncover the cause of this rapid subsidence.
- **Recovery Plan:** The High-Level Committee, under the chairmanship of Union Home Minister and Minister of Cooperation, Shri Amit Shah, approved the Recovery and Reconstruction (R&R) plan of Rs. 1658.17 crore for Joshimath.
- **Build Back Better:** The recovery plan for Joshimath will be implemented in three years, following the best practices, **Build Back Better (BBB)** principles and sustainability initiatives. Thereafter, Joshimath will emerge as an excellent example of ecological sustainability.

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## Odisha Rail Accident 2023

### Background

On 2 June 2023, three trains collided in Balasore district in Odisha state of eastern India. The Coromandel Express entered the passing loop instead of the main line near Bahanaga Bazar railway station at full speed and collided with a goods train.

**Fig 5.8 :** Odisha Rail Accident 2023



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### Short-Term Measures for Recovery and Reconstruction

- **Emergency Response Enhancement:** Strengthening the initial disaster response to minimise casualties and enhance the efficiency of relief operations.
- **Immediate Infrastructure Repair:** Swiftly addressing damaged infrastructure, including tracks, bridges, and signalling systems, ensuring rapid restoration to revive normalcy and prevent further disruptions.
- **Community Involvement:** Prioritizing community participation in reconstruction plans, incorporating local knowledge and needs to foster a sense of ownership and ensure sustainable development.
- **Environmental Restoration:** Integrating environmental protection measures into recovery efforts, emphasizing initiatives like afforestation and slope stabilization to prevent future disasters.
- **Accountability Mechanisms:** Establishing robust accountability mechanisms to ensure the efficient use of resources and timely implementation of recovery plans, implementing grievance redressal mechanisms to address issues promptly.

## Uttarakhand Floods 2013: A Case Study

- **Background:** The Uttarakhand floods of 2013, triggered by a cloud burst, wreaked havoc on the state during the monsoon season. The disaster disrupted life, causing extensive damage to property, and infrastructure, and claiming numerous lives, leading to the suspension of the famous Char Dham pilgrimage for three years.
- **Response and Relief Measures:** This includes a wide range of activities including the erection of control booths, action according to the action plan drafted, and the broadcasting of danger notice. Post the disaster various relief measures were initiated by the authorities in the form of rescue missions by the Indian Armed Forces.
- **Reconstruction:**
  - Erection of new buildings, taking ultra care of durability while erecting various essential facilities.
  - The government took the initiative to raise funds from both the public and private fronts.

## Kutch Earthquake (2001)

- **Overview:** The Kutch earthquake measuring 7.9 on the Richter Scale on January 26, 2001, was a major disaster in Gujarat, posing significant challenges for rescue, relief, and rehabilitation due to its size and impact.
- **Devastation:**
  - Over 37.8 million people were affected as the devastating earthquake with an epicentre north-east of Bhuj city, destroyed homes, schools, roads, communication systems and power lines.
- **Recovery:**
  - Within days of the earthquake, temporary health centres were set up in tents and a public health lab was established in a pre-fabricated structure in Bhuj to ensure continuity of health services and disease surveillance.
  - This was rapidly followed by GIS-based disease surveillance as an early warning mechanism to prevent outbreaks.
- **Role of NGO in Reconstruction:**
  - **Hunnarshala** went along a different path altogether, assisting villagers nearby to build thousands of **earthquake-resistant homes** with traditional technologies such as **rammed earth**.
  - For The pastoral communities living in the **Banni grassland** area near the **Rann of Kutch**, they chose to rebuild their homes by constructing their traditional **'bhungas'** instead of the pucca cement houses found in cities.

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## CONCLUSION

Effective disaster recovery, relief, and reconstruction are vital components of comprehensive disaster management. These processes require careful planning, coordination, and implementation to minimise the impact of disasters on affected communities. Successful recovery efforts focus on restoring essential services, infrastructure, and livelihoods while addressing the long-term needs of the affected population. Emphasising community participation, resilience-building, and sustainable development can enhance the effectiveness of post-disaster efforts. Continuous learning, adaptation, and collaboration among stakeholders are essential for improving disaster management practices and building more resilient societies in the face of future challenges.



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# Disaster Management: Institutions and Policy Guidelines

6

## INTRODUCTION

India faces a multitude of natural and man-made disasters due to its diverse geographical and socio-economic landscape. These disa sters pose significant challenges to life, property, and infrastructure. In this chapter, we will explore how disaster management in India evolved and the measures (both, legal and institutional) that were taken by the Indian Government to manage disasters. We will understand how resources are analysed to manage disasters in a better manner. So, let's grasp the insights of proactive disaster preparedness and equip ourselves with the knowledge to face uncertainties with resilience and readiness.

## DISASTER MANAGEMENT: FROM THE BRITISH PERIOD TO NOW

Disaster management in India has evolved due to historical events, legislative changes, technical developments, and lessons learned from various disasters. The origins of an institutional structure for disaster management may be traced back to the British period following a succession of disasters such as the famines of 1900, 1905, 1907, and 1943, as well as World War II. The earthquake that struck Bihar and Nepal in 1934. Over the past century, disaster management in India has undergone substantive changes in its composition, nature, and policy.

**Reactive approach:** Before 1947, disaster responses were frequently localised and community-driven. Relief departments were established during the British administration in the event of a tragedy.

- An activity-based design with a reactive approach proved only useful in post-disaster settings. **The policy was relief-oriented** with initiatives such as developing relief rules and launching food-for-work programmes.

### Major Disaster Related Commissions During The British Period

- **Campbell Commission, 1866:** Following a devastating famine that claimed the lives of 20 lakhs people, a committee **chaired by Sir George Campbell** was formed to investigate the causes of the tragedy, and it attributed the disaster to deficiencies in the government machinery.
- **Strachey Commission, 1880:** The devastating **famine of 1876-78** forced **Lytton's administration to appoint a** commission led by **Richard Strachey.** Among the recommendations were periodic adjustments of wages to ensure ample food for labourers, the state's obligation to offer gratuitous relief to the impoverished, and the identification of eligible individuals for such aid. The commission also provided insights on the suspension and remission of land revenue and rents. It advocated for provincial governments to bear the costs of famine relief, with central assistance available as needed. Accepting these recommendations, the government initiated steps to establish a famine fund. Subsequently, in 1883, the provisional **famine code was formulated,** which served as a guide and foundation for the development of provincial famine codes.
- **McDonnell Commission,1900:** After the famine of 1899-1900, Lord Curzon appointed a famine commission led by McDonnell. The commission advocated a moral strategy, early distribution of advances for seed and cattle purchase, and the creation of temporary wells. It also proposed the appointment of a famine commissioner in provinces expecting extensive relief operations and encouraged increased non-official assistance. While Lord Curzon accepted most of the commission's recommendations and implemented various measures to prevent and combat famine before leaving India, many of these initiatives were carried out with less than full commitment.

### Post Independence Developments

- **Initial structure:** Following independence, the job of disaster management remained with the **Relief Commissioners** in each state, who worked under the **Central Relief Commissioner**, with their role limited to the delegation of relief goods and money.
- **Five-Year Plans:** Every five-year plan addressed flood disasters under "Irrigation, Command, and Control", "Flood Control and Area Development".
- Repeated incidence of floods and resulting havoc inspired the formation of the **National Flood Control Program in 1954**, with a focus on flood mitigation and management.
- **Disaster Management Committee:** This was established in 1957, marking one of the earliest attempts at organised disaster management.

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## National Disaster Management Framework (1990s-Present)

- **National Flood Commission:** It was set up by the Ministry of Agriculture and Irrigation in 1976, to study India's flood-control measures after the projects launched under the National Flood Control Programme of 1954 failed to achieve much success.
- **Disaster Management Cell:** Following the recognition of the decade of 1990 as the '**International Decade for Natural Disaster Reduction'** (IDNDR) by the UN General Assembly, a permanent and institutionalised structure began in the 1990s with the establishment of a disaster management cell **under the Ministry of Agriculture**.
- **High-Powered Committee on Disaster Management 1999:** The HPC was constituted in August 1999 under the Chairmanship of **Shri J.C. Pant.** HPC members were drawn from the Ministries, States, NGOs, and experts drawn from relevant fields. It was a first attempt in India towards drawing up a systematic, comprehensive, and holistic approach towards disasters.
  - **Revision of existing system of response mechanism** in the wake of natural and manmade disasters at all levels of government and introduction of steps to minimise the response time through effective communication and measures to ensure adequacy of relief operations.
  - **Development programmes related to mitigation of disaster management** in different areas and priorities and strategies for inclusion of disaster reduction components in the ongoing plan/non-plan schemes have to be considered.
  - **Measures need to be introduced for intensive training for building up of human resources** to improve disaster awareness and capabilities, and also public awareness programs to build up society's resilience towards disasters.
  - **Pro-active measures for disaster preparedness and mitigation** in administrative, financial, legislative and techno-legal aspects.
  - **Measures and programs to harness state-of-the-art Information Technology for effective communication networks.** Networking mechanism by Government/ NGOs. This would also improve advance warning systems against disasters.
  - **Review of Global Best practices including study of the UN System** and the Disaster Preparedness and Response mechanism of several countrie
- **National Disaster Management Authority:** The 1999 Orissa Super Cyclone, Bhuj Earthquake, 2001 and 2004 Tsunami were the watershed moments that resulted in the establishment of the National Disaster Management Authority (NDMA) in 2005.
  - The Disaster Management Act of 2005 established a legislative framework for disaster management.
  - State Disaster Management Authorities (SDMAs) and District Disaster Management Authorities (DDMAs) were formed by the Act.

# DISASTER MANAGEMENT STRUCTURE

India, being a country prone to various natural disasters, has implemented a comprehensive and multi-layered structure for disaster management. This structure involves various institutions and agencies working together at national, state, and district levels.

## Disaster Management Act, 2005

The introduction of the **National Disaster Management Act (NDMA) in 2005** marked a **significant transformation** in India's disaster management strategy. The **shift** was from a **primarily response and relief-centric approach to** a **more proactive emphasis on preparedness, prevention, and planning.**

The DM Act of 2005 **provides for the setting up of Disaster Management Authorities (DMA) at the national (NDMA), state (SDMA) and district (DDMA) levels.** The DM Act does **not** have any **provisions** for **notifying** any **disaster as a 'national calamity' or a 'national disaster.'** In most cases, **state governments will be carrying out disaster management, with the central government playing a supporting role.** Generally, the central agencies will participate in the request from the state government. Within each state, there is a separate institutional framework for disaster management at the state level.

The extent of involvement of central agencies depends on the type, scale, and administrative spread of the disaster. If the situation requires direct assistance from the central government or the deployment of central agencies, the central government will provide all necessary support. The institutional arrangements have been set up consistent with the paradigm shift from the relief-centric approach of the past to a proactive, holistic and integrated approach for Disaster Risk Reduction (DRR) by way of strengthening disaster preparedness, mitigation, and emergency response.



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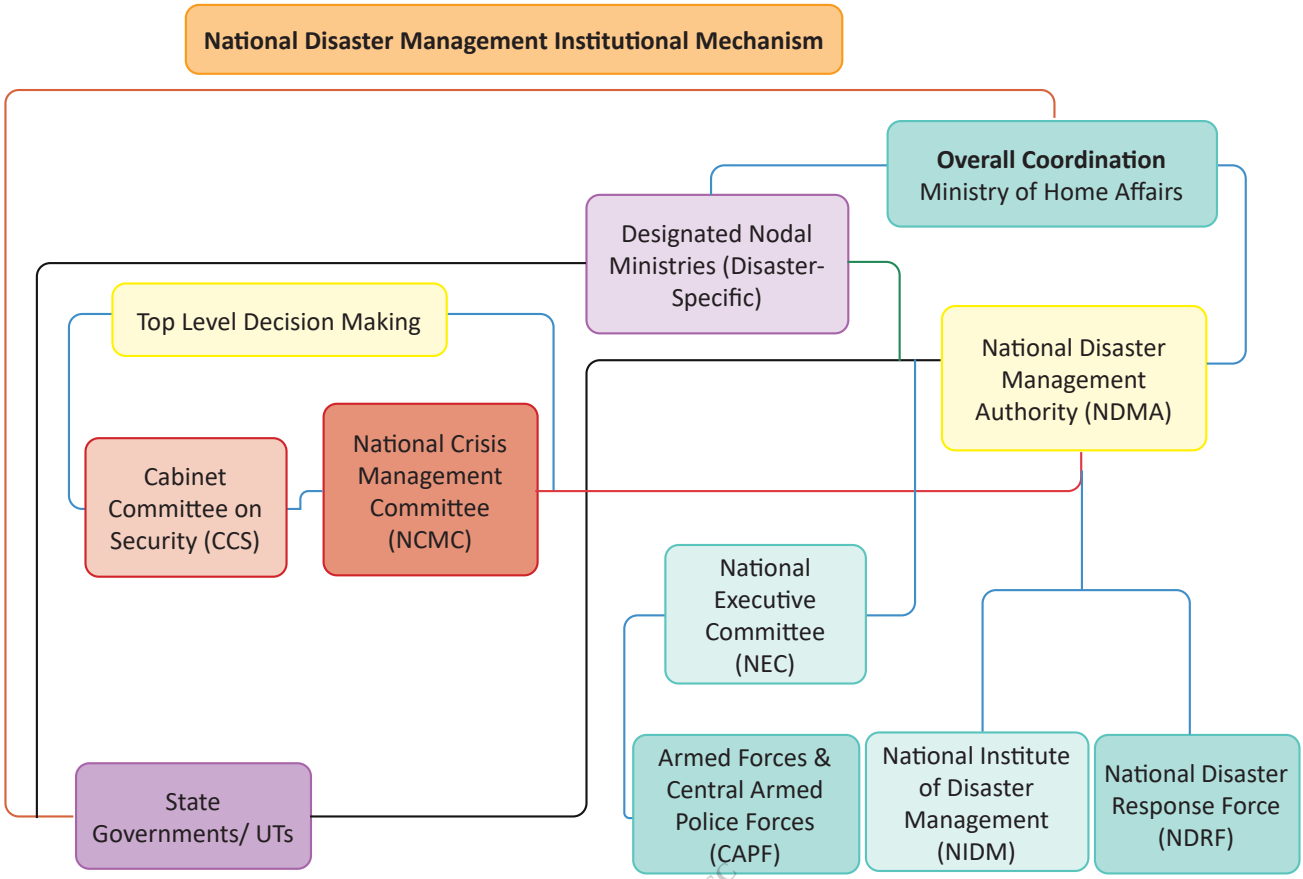


**Fig. 6.1:** National Disaster Management Institutional Mechanism

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## Role of Home Ministry

**Function:** On behalf of the Central Government, Disaster Management Division in the Ministry of Home Affairs(MHA) **coordinates** with disaster affected State Government(s), concerned line ministries/departments, National Disaster Management Authority (NDMA), National Disaster Response Force (NDRF), National Institute of Disaster Management (NIDM) and the Directorate General of Fire Services, Home Guards and Civil Defence, and Armed Forces for effective disaster risk reduction. The Division is responsible for legislation, policy, capacity building, prevention, mitigation, response and long term rehabilitation

**Central Relief Commissioner (CRC):** CRC in the Ministry of Home Affairs is the **nodal officer to coordinate relief operations for natural disasters.** The CRC receives information relating to forecasting/warning of a natural calamity from India Meteorological Department (IMD) or from Central Water Commission of Ministry of Water Resources on a continuing basis.

**Crisis Management Group(CMG):** The Central Relief Commissioner is the Chairman of the CMG, consisting of senior officers (called nodal officers) from various concerned Ministries. The CMG's functions are to review every year contingency plans formulated by various Ministries/ Departments/Organizations in their respective sectors, measures required for dealing with a natural disasters, coordinate the activities of the Central Ministries and the State Governments in relation to disaster preparedness and relief and to obtain information from the nodal officers on measures relating to above.

**Nodal Ministry for Management/Mitigation of Various Disasters**

| | Disaster | Nodal Ministry/ Department |
|---|---|---|
| 1. | Biological | Ministry of Health and Family Welfare (MoHFW) |
| 2. | Chemical and Industrial | Ministry of Environment, Forest sand Climate Change (MOEFCC) |



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|---|---|---|
| 3. | Civil Aviation Accidents | Ministry of Civil Aviation (MoCA) |
| 4. | Cyclone/Tornado | Ministry of Earth Sciences (MoES) |
| 5. | Tsunami | Ministry of Earth Sciences (MoES) |
| 6. | Drought/Hailstorm/Cold Wave and Frost/Pest Attack | Ministry of Agriculture and Farmers Welfare (MoAFW) |
| 7. | Earthquake | Ministry of Earth Sciences (MoES) |
| 8. | Flood | Ministry of Jal Shakti |
| 9. | Forest Fire | Ministry of Environment, Forests, and Climate Change (MoEFCC) |
| 10. | Landslides | Ministry of Mines (MoM) |
| 11. | Avalanche | Ministry of Defence (MoD) |
| 12. | Nuclear and Radiological Emergencies | Dept. of Atomic Energy (DAE) |
| 13. | Rail Accidents | Ministry of Railways (MoR) |
| 14. | Road Accidents | Ministry of Road Transport and Highways (MoRTH) |
| 15 | Urban Floods | Ministry of Urban Development (MoUD) |

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### Key National-Level Decision-Making Bodies For Disaster Management

| Name | Composition | Function |
|---|---|---|
| **Cabinet Committee on Security (CCS)** | Prime Minister, Minister of Defence, Minister of Finance, Minister of Home Affairs | ❑ Evaluation from a national security perspective, if an incident has potential security implications<br>❑ Oversee and review all aspects of preparedness, mitigation and management of Chemical, Biological, Radiological and Nuclear (CBRN) emergencies and of disasters with security implications |
| **National Crisis Management Committee (NCMC)** | Cabinet Secretary (Chairperson)<br>Secretaries of Ministries/ Departments and agencies with specific Disaster Management responsibilities | ❑ Oversee the **Command, Control and Coordination of the disaster response.**<br>❑ Give direction to the Crisis Management Group as deemed necessary.<br>❑ Give direction for specific actions to face crisis situations. |
| **National Disaster Management Authority (NDMA)** | Prime Minister (Chairperson)<br>Members (not exceeding nine, nominated by the Chairperson) | ❑ Lay down policies, plans and guidelines for disaster management<br>❑ Coordinate their enforcement and implementation throughout the country<br>❑ Approve the NDMP and the DM plans of the respective Ministries and Departments of Government of India<br>❑ Lay down guidelines for disaster management to be followed by the different Central Ministries, Departments and the State Governments<br>❑ The NDMA has the mandate to deal with all types of disasters – **natural or human-induced.** |



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| **National Executive Committee (NEC)** | Union Home Secretary (Chairperson) | ❑ To assist the NDMA in the discharge of its functions<br>❑ Preparation of the National Disaster Management Plan<br>❑ Coordinate and monitor the implementation of the National Policy on Disaster Management<br>❑ Direct any department or agency of the Govt. to make available to the NDMA or SDMAs such men, material or resources as are available with it for emergency response, rescue and relief<br>❑ Coordinate with the Armed Forces, Central Armed Police Forces (CAPF), the National Disaster Response Force (NDRF) and other uniformed services which comprise the GOI's response to aid the State authorities<br>❑ Coordinate with SDRF, civil defence volunteers, home guards and fire services, through the relevant administrative departments of the State Governments |
| **National Disaster Response Force (NDRF)** | Specially trained force headed by a Director General Structured like paramilitary forces for rapid deployment | ❑ The National Disaster Response Force (NDRF) was established under Section 44 of the DM Act, 2005 by converting 16 battalions of Central Para Military Forces (BSF, ITBP, CISF, and CRPF) into a specialist force for disaster response.<br>❑ Assist the relevant State Government/District Administration in the event of an imminent hazard event or in its aftermath.<br>❑ The general superintendence, direction, and control of the National Disaster Response Force (NDRF) are vested in and exercised by the NDMA. |
| **National Institute of Disaster Management (NIDM)** | Union Home Minister; Vice Chairperson, NDMA | ❑ Human resource development and capacity building for disaster management within the broad policies and guidelines laid down by the NDMA<br>❑ Design, develop and implement training programmes<br>❑ Undertake research<br>❑ It works within the framework of broad policies and guidelines laid down by the NDMA |

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**IGNITE YOUR MIND**

How can the centralised structure of NDMA be further decentralised to empower local communities and state governments to manage their own disaster risks and response measures? Do you think local knowledge and traditional practices can be leveraged to complement top-down strategies?

## State-Level Disaster Management

As per the DM Act of 2005, each state in India/ Union Territory (UT) shall have its own institutional framework for disaster management.

### Disaster Management Department

Each State/UT will have one nodal department for coordination of disaster management called the **DM department (DMD)**. The DM Act mandates that each State/ UT shall take necessary steps for the preparation of State/ UT DM plans, integration of measures for the prevention of disasters or mitigation into State/UT development plans, allocation of funds, and establishment of an Early warning system. Depending on specific situations and needs, the State/UT shall also assist the Central Government and central agencies in various aspects of DM. Each state shall prepare its own State Disaster Management Plan.

### State Disaster Management Authority

- **Formation:** The DM Act mandates the setting up of a State Disaster Management Authority (SDMA) and a similar system in each state and UT.
- **Function:** The SDMA will approve the **disaster management plans** prepared by various departments. It will also approve the **State Plan** by the guidelines laid down by the NDMA, coordinate the implementation of the State Plan, and recommend the provision of funds for mitigation and preparedness measures.

### State Executive Committee

The State Government shall constitute a State Executive Committee (SEC) to assist the SDMA in the performance of its functions. The SEC will be headed by the Chief Secretary to the State Government. The SEC will coordinate and monitor the implementation of the National Policy, the National Plan, and the State Plan. The SEC will also provide information to the NDMA relating to different aspects of DM.

### District Disaster Management Authority (DDMA)

At the district level, there is provision of DDMA coordinated by the District Magistrate or the Deputy Commissioner. It will be responsible for overall coordination of the disaster management efforts and planning.



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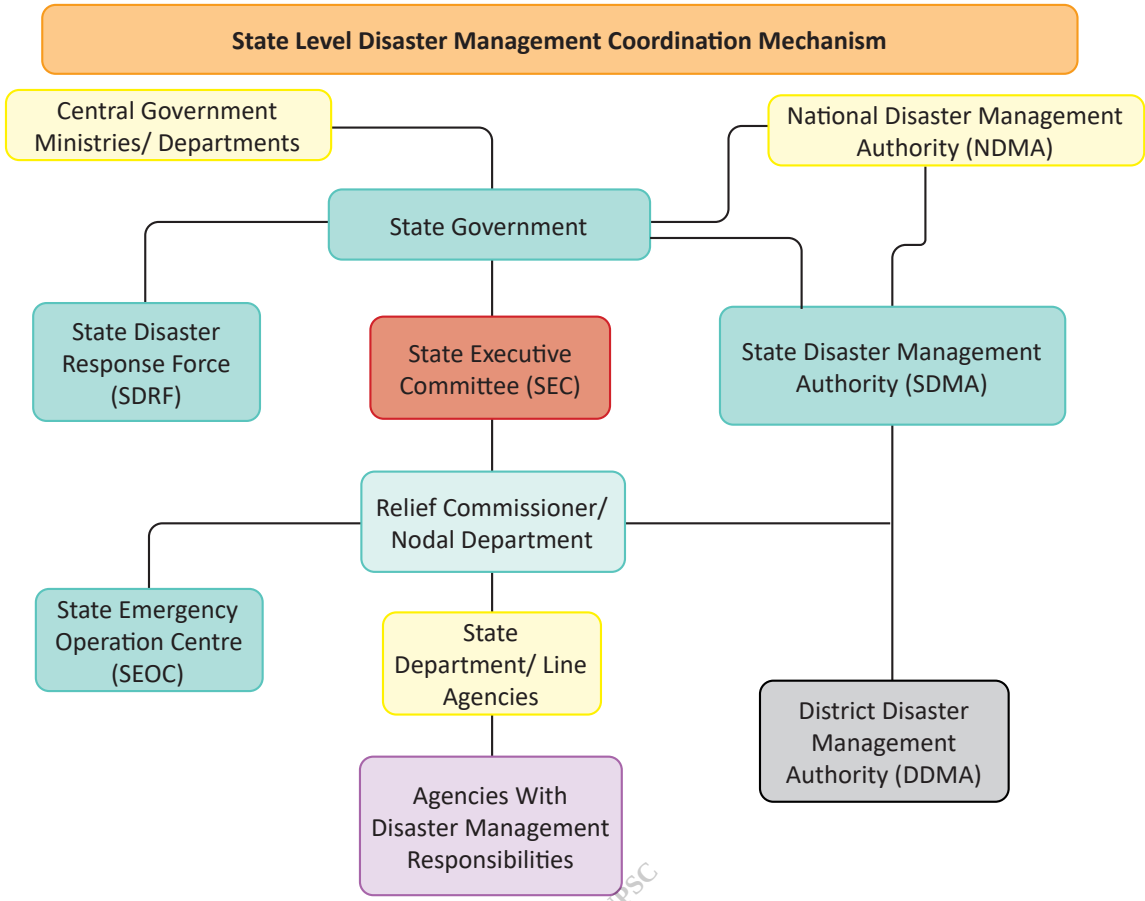


**Fig. 6.2:** State-Level Disaster Management Coordination Mechanism

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**IGNITE YOUR MIND**

Local elders, farmers, and indigenous groups become citizen scientists, sharing knowledge of flood cycles, erosion patterns, and ancient warning signs gleaned from nature. Can you think of the ways in which state agencies can involve people in the mitigation and rescue process to make it more democratic and participative along with technology integration.

## State Disaster Response Force (SDRF)

The State Disaster Response Force (SDRF) is an integral part of India's disaster management system. Established under the Disaster Management Act, of 2005, each state and union territory (UT) has its own SDRF for responding to various natural and man-made disasters.

### Functions of SDRF

- **Emergency Response:** SDRF teams are trained and equipped to handle various disaster situations, including floods, cyclones, earthquakes, landslides, and chemical emergencies. They are responsible for search and rescue operations, medical assistance, damage assessment, evacuation, and community engagement.
- **Disaster Preparedness:** SDRF personnel actively participates in drills and exercises to enhance their skills and readiness for responding to emergencies.
- **Awareness:** They also conduct awareness campaigns and community outreach programs to educate citizens about disaster preparedness and risk reduction measures.
- **Coordination:** The SDRF works closely with other agencies involved in disaster management, including the National Disaster Response Force (NDRF), District Disaster Management Authority (DDMA), and State Disaster Management Authority (SDMA).

## Rules Notified Under The Disaster Management Act

- **Disaster Management(National Institute of Disaster Management) Rules, 2006:** It provides for the makeup of the institution and governing body, the filling of vacancies, institute meetings, and the authorities and functions of the Executive Director.
- **National Institute of Disaster Management Regulations, 2006:** It provides for Composition of the institute and the governing body.



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- **Disaster Management (Annual Report of National Authority) Rules, 2006:** It provides for the inclusion of the contents in the annual report and its presentation to both Houses of Parliament within nine months of the end of the fiscal year.
- **Disaster Management (Notice of Alleged Offence) Rules, 2007:** It provides for notification of alleged offence and intent to file a complaint, as well as the specifications to be provided with the notice.
- **Disaster Management (National Disaster Management Response Force) Rules, 2008:** It provides for the formation of the force; its direction and control; responsibility, training, skill, duties, and so on; and the conditions of service of the NDRF.

## ISSUES WITH THE DISASTER MANAGEMENT ACT, 2005

- **Reactive and piece-meal approach:** Disaster management in India has focused more on immediate response (search and rescue, food and water etc.) while recovery, rehabilitation, preparedness, and mitigation have been neglected.
- **Functional crossovers and confusion:** Though the Act provides for forming of various bodies at all levels, there is an overlap of duties, and there is no streamlined mechanism of cooperation among the governing bodies.
- **Misutilization of funds:** A 2018 CAG report on Uttarakhand's post-flood reconstruction (Report No. 2 of 2018) revealed irregularities in fund utilization, including delays, lack of transparency in procurement, and discrepancies in project completion certificates.
- **Limited Scope:** The Act primarily focuses on post-disaster response and relief, overlooking the crucial aspects of prevention, mitigation, and preparedness.
- **Centralised Authority:** The Disaster Management Act vests significant power in the Central Government, leading to concerns about overreach and bureaucratic hurdles at the state and local levels.
- **Lack of Accountability:** The Act lacks clear mechanisms for holding authorities accountable for their actions or inaction during disaster management. This can lead to inefficiency, corruption, and inadequate response in certain situations.
- **District Funds Have Not Been Established:** The Act requires the formation of disaster response and mitigation funds at the district level, but this provision has yet to be implemented.
- **Delayed Response and Policy Implementation:** There are concerns about delayed response times and policy implementation.
  - The devastating floods that ravaged Kerala in 2018 serve as a stark example of how delayed response and implementation can exacerbate the impact of natural disasters.
- **Procedural Delays:** Timely and effective action might be hampered by lengthy bureaucratic procedures.
- **Resource Constraint:** The allocation of resources for disaster management remains inadequate at all levels. This limits the capacity to effectively implement mitigation and preparedness measures, ultimately impacting response capabilities.
- **Inadequate Community Participation:** The Act encourages community participation, but the actual implementation often falls short. This leads to limited ownership and engagement from communities, hindering the effectiveness of disaster management efforts.
- **Data and Information Management:** Weak data collection, analysis, and dissemination hinders effective risk assessment, preparedness planning, and response coordination.
- **Climate Change and Emerging Threats:** The Act does not explicitly address the growing threat of climate change and emerging risks like pandemics.
- **No Integration Of Development With Disaster:** The Act lacks a strong emphasis on integrating disaster risk reduction into development plans. This can lead to vulnerability being built into infrastructure and settlements, exacerbating disaster impacts.

The DMA must be thoroughly reviewed and amended to address these shortcomings. Communities, specialists, and civil society organisations should participate in this multi-stakeholder approach.

### Way Forward (Disaster Management Act)

- **Strengthening decentralisation:** Empowering local authorities and communities through capacity building and resource allocation can lead to more context-specific and effective disaster management.
- **Promoting community engagement:** Actively involving communities in risk assessments, preparedness plans, and early warning systems can build resilience and ownership.
- **Clarifying roles and responsibilities:** Defining clear mandates and establishing coordination mechanisms between different agencies can streamline response and avoid duplication of efforts.
- **Enhancing financial resources:** Exploring sustainable funding mechanisms like disaster insurance and public-private partnerships can ensure adequate resources for preparedness and recovery.
- **Adapting to climate change:** The Act needs to be updated to incorporate climate change considerations, including risk assessment, mitigation strategies, and adaptation plans for specific hazards.
- **Regular review and amendments:** Periodic evaluations of the Act's effectiveness and responsiveness to evolving disaster landscapes are crucial for continuous improvement.



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### Institutional Framework for Metropolitan Cities

- The government has accepted the recommendation of the **second Administrative Reforms Commission** that in larger cities with a population of more than 2.5 million the Mayor, assisted by the Municipal Corporation Commissioner and the Police Commissioner, be directly responsible for Crisis Management.
- However, the **full implementation of the recommendations** has been slow and **uneven** across different states.

## CIVIL DEFENCE

- **Origin:** Civil Defence in India traces it origin from World War II when the need for civilian readiness against air attacks and other wartime threats became apparent.
  - Civil Defence (CD) legislation, known as the **Civil Defence Act,** was enacted in 1968 and is currently in effect throughout the country.
- **Civil Defence And Disaster Management:** The above Act was amended in 2009 and given responsibility to play a proactive role in disaster management.
- **Role of Civil Defence:** During war and emergencies, the CD organisation plays a vital role in protecting the hinterland, supporting the military, mobilising citizens, and assisting civil administration in efforts to save lives and property, minimise damage, maintain production centres, and boost morale.
  - Over the time, CD has expanded beyond conventional weapon damage management to encompass threats from nuclear, biological, chemical, and environmental calamities.
  - **For example:** In Kerala Floods (2023) over 10,000 CDF personnel were deployed for rescue and relief operations. They helped evacuate stranded residents, provided first aid and medical assistance, and distributed essential supplies like food and water. Their swift action and local knowledge were vital in mitigating the impact of the floods.
  - Civil Defence is primarily organised on a voluntary basis except for a small nucleus of paid staff and establishment which is augmented during emergencies
- **Civil Defence Setup In The States:** To coordinate with the actions of the Controllers of Civil Defence, the state government chooses a Director of Civil Defence and may establish a Civil Defence Corps for specific areas.
- **Civil Defence at The District Level:** The state government can designate a person named "Controller" who is not below the status of a District Magistrate.
  - The state government can appoint a Deputy Controller of Civil Defence with a status equivalent to a Deputy Collector but not below a Sub-Divisional Magistrate under specific conditions.

### National Civil Defence College (NCDC), Nagpur

- The National Civil Defence College, formerly known as Central Emergency Relief Training Institute (CERTI), was founded in Nagpur district in 1957 to serve the Emergency Relief Organisation of the Government of India.
- The Institute provided specialised training for revenue officers in disaster relief operations for natural or artificial disasters.
- The institution now serves as a focal point for disaster management training and emergency response training for radiological, nuclear, biological, and chemical hazards.

## FIRE SERVICES

- **Establishment:** In 1955, the Indian government established a "**Standing Fire Advisory Committee**" under the Ministry of Home Affairs. The group aimed to assess technical issues in Fire Services and advise the Indian government on the rapid development and upgrading of these services nationwide.
  - The Committee was **renamed "Standing Fire Advisory Council" (SFAC)** in 1980.
- **Present Status:** According to **item 7 of Schedule 12 of Article 243W** of the constitution, **Municipal Bodies** are responsible for providing fire services.
  - Fire prevention and fighting services are currently organised by relevant states and UTs. The Ministry of Home Affairs, Government of India, provides technical guidance on fire protection, prevention, and legislation to States, UTs, and Central Ministries.

### National Fire Service College (NFSC), Nagpur

- The National Fire Service College, established in 1956 under the Ministry of Home Affairs, aims to train fire officers in advanced techniques and create uniformity in fire service organisations and management nationwide.

## HOME GUARDS

- **Establishment:** Home Guards are raised by the Home Guards Act and the rules of the various states and UTs.
- **Composition:** They are recruited from amongst all classes of people and walks of life, who give their spare time to the organisation for betterment of the community.
- **Controlling Authority:** The Ministry of Home Affairs develops policies for the Home Guards Organization's function, target, raising, training, equipping, establishment, and other vital issues.

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- **Types:** Home Guards are divided **into two types:** Rural and Urban, and border states have **Border Wing Home Guards Battalions** at the national level.
  - Border Wing Home Guard acts as an auxiliary to the Border Security Force.
  - **Marine Home Guard:** Functions as an auxiliary to the Indian Coast Guard in coastal areas, assisting in patrolling, search and rescue operations, and maritime law enforcement.

### Roles and Responsibilities of Home Guards

- To assist police in maintaining law and order.
- To prevent crime and participate in anti-crime patrols.
- To contribute to disaster relief and rehabilitation efforts.
- To provide traffic management and crowd control support.
- To engage in social welfare activities and community development programs.

## CIVIL SOCIETY AND DISASTER MANAGEMENT

Disasters have a substantially lower effect, notably in terms of loss of life, when communities are equipped and prepared' - United Nations Office for Disaster Risk Reduction (UNISDR). Community-based disaster management has emerged as a top goal in catastrophe risk reduction. Civil society plays an important enabling role in supporting disaster risk reduction action, from the development and implementation of relevant policies, laws, and regulations. Recognizing the paramount role of civil society and community-based organizations in promoting and implementing disaster risk reduction as there is a need to strengthen the voice and engagement of stakeholders in the implementation of disaster management.

### Importance of Community-Based Disaster Management (CBDM)

- **Disaster risk reduction measures:** It involves identifying vulnerable populations, utilizing community-based preparedness and early warning systems. However, inadequate understanding of local risk behaviour can lead to poorly designed systems.
- **Benefits of participation:** Local participation in emergency management ensures self-reliance, meets local needs, and incorporates indigenous knowledge. Organized communities enforce downward accountability and provide sustainable assistance.
- **Bottom-Up Approach:** Community-Based Disaster Management (CBDM) is a bottom-up approach that combines top-down strategies to identify and address challenges and difficulties in disaster management.

### Indian DM Framework and Community-Based Disaster Management

- **Promotes Community Training And Awareness:** The 2005 Disaster Management Act promotes community training and awareness programs for disaster prevention and mitigation, involving local authorities, NGOs, and grassroots social-welfare organizations.
- **The National Policy on Disaster Management 2009:** It emphasizes community-based disaster preparedness, training, simulations, and mock drills for vulnerable sections, recognizing the community as the foundation of disaster response.
- **The National Disaster Management Plan (NDMP) 2016:** It aims to enhance India's disaster resilience and reduce damage, following the Sendai Framework for Disaster Risk Reduction guidelines.
- They are related to Investing in disaster preparedness by structural and nonstructural means, recognising disaster risk, enhancing disaster risk governance, and improving catastrophe readiness in order to respond effectively and rebuild more quickly after a disaster.

## THE COORDINATION/INTERFACE BETWEEN THE MINISTRIES FOR DISASTER MANAGEMENT

The interface between stakeholders and the disaster management framework is permanent and governed by legislative measures and government orders. These decisions determine the structure's composition, identifying stakeholders to be involved. Each stakeholder's role is evolving and defined within different Standard Operating Procedures (SOPs). While stakeholder involvement is mandated and permanent, the nature of the interface is guided by their expertise or relevance to the disaster management framework.

**Example of stakeholder involvement includes:** The Indian Meteorological Department (IMD) and Central Water Commission (CWC) providing weather and climatic information to the nodal management authority and aid in disaster planning activities like flood zonation and flood plain management. **The Department of Space** provides research and technical support by monitoring weather elements, facilitating satellite-based communication, and undertaking activities like land use mapping and hazard zoning.

Overall, an effective interface between the Ministries for disaster management in India requires strong coordination, resource allocation, data sharing, and community engagement. By addressing existing challenges and implementing effective strategies, India can build a more resilient and prepared nation against disasters.



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# MAJOR PLANS AND POLICIES

## National Policy on Disaster Management (NPDM), 2009

The National Policy on Disaster Management (NPDM) was developed following and in response to the Disaster Management Act of 2005. The NPDM will give a framework/ roadmap for dealing with catastrophes holistically.

- **Vision:** To create a safe and **disaster-resilient India** by implementing a comprehensive, proactive, multi-disaster, and technology-driven approach based on a culture of prevention, mitigation, readiness, and response.
- **Coverage area:** The Policy **addresses all aspects of disaster management**, including institutional, legal, and financial arrangements; disaster prevention, mitigation, and preparedness, as well as a techno-legal regime; response, relief, and rehabilitation; reconstruction and recovery; capacity development, knowledge management, and research and development.
  - It focuses on the areas where action is required as well as the institutional mechanisms that might channel such activity.
- **Inclusivity:** In terms of awarding relief and creating measures for disaster rehabilitation, the NPDM addresses the concerns of all sections of society, including differently-abled people, women, children, and other disadvantaged groups.

### Objectives

- To reduce the risk of disasters through mitigation and preparedness measures.
- To ensure prompt and effective response to disasters.
- To provide relief and rehabilitation to the affected population.
- To promote disaster risk reduction (DRR) in all sectors.
- To build capacity for disaster management at all levels.
- To create a culture of safety and resilience.

Through the involvement of the community, community-based organisations, Panchayati Raj Institutions (PRIs), local bodies, and civil society, the NPDM aspires to increase openness and accountability in all aspects of disaster management.

## National Disaster Management Plan, 2016

The NDMP serves as a document or guideline for the government agencies to act in all phases of disasters. It is based on the Sendai Framework, which is a United Nations framework, for substantially reducing disaster risk, and losses to lives and livelihoods. The NDMP is also as per the Disaster Management Act, 2005 and the National Policy on Disaster Management, 2009.

### Objectives of NDMP

Along with the mandate given in the DM Act 2005 and the NPDM 2009, the national plan has incorporated the national commitments in the domain of DRR associated with the three major post 2015 global frameworks and the PM's Ten Point Agenda. Accordingly, the broad objectives of the NDMP are:

- **Improve the understanding** of disaster risk, dangers, and vulnerabilities.
- Improve catastrophe risk governance at all levels, from local to national.
- **Invest in catastrophe risk reduction** for resilience by taking structural, non-structural, and financial measures, as well as developing comprehensive capacity.
- **Improve disaster preparedness** for a more effective response.
- **Encourage "Build Back Better"** in the areas of healing, rehabilitation, and reconstruction.
- Prevent disasters and reduce disaster risk and losses in lives, livelihoods, health, and assets (economic, physical, social, cultural, and environmental).
- **Increase resilience and minimise existing risks** while preventing the introduction of new catastrophic hazards.
- Encourage the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technical, political, and institutional catastrophe prevention and mitigation strategies.
- Empower both local governments and communities to work together to prevent and manage catastrophe risks.
- Improve scientific and technological capacity in all areas of catastrophe management.
- Capacity building at all levels to respond effectively to multiple threats and to manage community-based disasters.

### Salient Features of the Plan

- **Comprehensive Disaster Management:** The plan addresses all aspects of disaster management, including prevention, mitigation, response, and recovery.
- **Priorities:** The approach employed in this national plan includes the four priorities enunciated in the Sendai Framework into the disaster risk reduction planning framework under the **five Thematic Areas for Actions**:
  1. Understanding Risk
  2. Inter-Agency Coordination
  3. Investing in Disaster Risk Reduction - Structural Measures

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4. Investing in Disaster Risk Reduction - Non-Structural Measures
5. Capacity Building

- **Prevention and Mitigation:** Implementing structural and non-structural measures to minimize the impact of disasters.
  - Examples include building **earthquake-resistant houses, planting trees to prevent landslides,** and promoting public awareness about disaster preparedness.
- **Preparedness and Early Warning:** Developing and implementing early warning systems for timely alerts to communities in case of impending disasters.
- **Defines Roles of Various Stakeholders:** It advocates horizontal and vertical integration of all government offices and divisions. In a matrix style, the plan also specifies the functions and responsibilities of all levels of government, all the way up to the panchayat and urban local body level.
- **Region-Specific Approach:** The plan takes a regional approach, which will help with both disaster management and development planning.

## Changes Brought to NDMP in 2019

The National Plan on Disaster Management (NDMP) underwent significant revisions in 2019, in order to address various limitations and adapting to evolving disaster landscapes.

- **Enhanced Scope and Coverage:** The revised plan expanded its scope to include 17 disasters compared to 11 in the 2016 version. This broader coverage acknowledges the growing threat of diverse risks.
- **Emphasis on social inclusion:** The 2019 plan explicitly focuses on social inclusion, ensuring marginalized communities' participation in disaster management activities.

**IGNITE YOUR MIND**

The National Plan on Disaster Management 2019 added a new chapter on social inclusion. Do you think the dedicated chapter on social inclusion translates into tangible outcomes for marginalised communities, ensuring their voices are heard and needs are addressed throughout the disaster management cycle? Can you think few more measures in this aspect?

- **Mainstreaming DRR:** The plan emphasizes mainstreaming Disaster Risk Reduction (DRR) into development planning across sectors, aiming for sustainable and resilient development.
- **Coherence with international frameworks:** The plan aligns with international agreements like the Sendai Framework for DRR, Sustainable Development Goals (SDGs), and Paris Agreement on Climate Change.
- **Dedicated chapter on social inclusion:** This new chapter underscores the importance of addressing vulnerabilities faced by marginalized groups and ensuring equitable access to resources during disasters.
- **Strengthening disaster risk governance:** The revised plan emphasizes robust governance mechanisms for effective DRR and response, including decentralization and community engagement.

The National Plan on Disaster Management plays a critical role in building resilience against natural and man-made disasters in India. By addressing existing challenges and continuously improving its implementation, India can strive towards a safer and more resilient future for its citizens.

### Subhash Chandra Bose Aapda Prabandhan Puraskar 2023

- **Subhash Chandra Bose Aapda Prabandhan Puraskar 2023:** This award was instituted by the Government of India to recognize the excellent work done by individuals and Institutions in India in the field of Disaster Management like Prevention, Mitigation, Preparedness, Rescue, Response, Relief, Rehabilitation, Research/ Innovations or Early Warning. In 2023 the award was given to following organisations.
  - **Odisha State Disaster Management Authority (OSDMA)** OSDMA was established in 1999 in the aftermath of the Super Cyclone. OSDMA embarked on multiple initiatives including raising of the Odisha Disaster Response Action Force (ODRAF), Multi-hazard Early Warning Service (MHEWS) framework, and a cutting-edge technology-enabled web/smartphone-based platform called SATARK (System for Assessing, Tracking, and Alerting Disaster Risk Information based on Dynamic Risk Knowledge). OSDMA provided effective response during various cyclones, Hudhud (2014), Fani (2019), Amphan (2020), and Odisha floods (2020). OSDMA conducted disaster preparedness initiatives in building community resilience in 381 tsunami-prone villages/wards and 879 multi-purpose cyclone/ flood shelters located within 1.5 km from the coastline.

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- **Lunglei Fire Station (LFS), Mizoram:** Responded efficiently and effectively to a massive forest fire which was reported on April 24, 2021, in the uninhabited forest areas that surrounded Lunglei town and spread to more than 10 village council areas. Lunglei fire station personnel assisted by local civilians worked continuously for more than 32 hours during which they motivated and provided on-the-spot training to residents.

## CONCLUSION

India's institutional mechanisms and policy landscape represent a significant leap forward in building a disaster-resilient nation. The establishment of NDMA, the implementation of the Disaster Management Act, and the integration of risk reduction into development plans are concrete examples of this commitment. These efforts have demonstrably saved lives, reduced economic losses, and empowered communities to cope with unforeseen disasters. While challenges remain, the institutional and policy framework for disaster management in India paints a picture of unwavering determination and resolute action. From the dedication of policymakers to the resilience of communities, a collective spirit shines through, promising a future where India confronts disasters not with fear, but with preparedness and a unified resolve to emerge stronger.

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# Funding Framework and Capacity Building

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## INTRODUCTION

Financial aid following natural disasters adheres to relief fund schemes aligned with the recommendations of successive Finance Commissions. The Ministry of Finance manages the budgetary allocations for these relief funds, while the Ministry of Home Affairs (DM Division) oversees the processing of state government requests for these funds. The primary responsibility for disaster management, including disbursal of relief to the affected people on the ground level, rests with the State Governments. The State Governments undertake relief measures in the wake of natural disasters from the State Disaster Response Fund (SDRF). Additional financial assistance is provided by the National Disaster Response Fund (NDRF), as per the laid down procedure, in the case of a disaster of a 'severe nature', which includes an assessment based on the visit of the Inter-Ministerial Central Team (IMCT).

## NATIONAL DISASTER RESPONSE FUND (NDRF)

- **Legal Status:** Section 46(1) of the Disaster Management Act 2005 mandates the establishment of the National Disaster Response Fund (NDRF) for addressing threatening disaster management situations.
- **Financial Arrangements for NDRF:** The Government of India finances the NDRF through the "National Calamity Contingency Duty," which is levied on various imported items, including petrol, crude oil, motor vehicles, mobile phones, pan masala, and specific tobacco products along with recommendations of the finance commission.
- **The process to get money from NDRF:** Beyond the provisions of the State Disaster Response Fund (SDRF), the NDRF provides additional financial assistance for calamities of severe nature.
- **Assessment Process:** Upon receiving a memorandum from affected states, an Inter-Ministerial Central Team (IMCT) is constituted. This team, comprising representatives from central ministries/departments, conducts an assessment. The report is then examined by the Inter-Ministerial Group (IMG), which is headed by the Home Secretary.
- **Approval Process:** Following the examination by the IMG, the report is placed before the High-Level Committee (HLC) for consideration and approval of funds from the NDRF. Currently headed by the Finance Minister, the committee includes the Home Minister, Minister for Agriculture, and the Vice-Chairman of the Planning Commission as its members.

## STATE DISASTER RESPONSE FUND (SDRF)

- **Legal Status:** The State Disaster Response Fund (SDRF), constituted under Section 48 (1) (a) of the Disaster Management Act, 2005, is the primary fund available to State Governments for responses to notified disasters.
- **Source of funding:** The Central Government contributes 75% of SDRF allocation for general category States/UTs and 90% for special category States/UTs (NE States, Sikkim, Uttarakhand, Himachal Pradesh, Jammu and Kashmir).
  - The annual Central contribution is released in two equal installments as per the recommendation of the Finance Commission.
  - SDRF shall be used only for meeting the expenditure for providing immediate relief to the victims.
- **Disaster (s) covered under SDRF:** Cyclone, drought, earthquake, fire, flood, tsunami, hailstorm, landslide, avalanche, cloudburst, pest attack, frost and cold waves.

### District Disaster Response Funds

District Disaster Response Funds and District Disaster Mitigation Funds are proposed to be created at the District Level as mandated by **Section 48 of the DM Act.** The disaster response funds at the district level would be used by the District Disaster Management Authority (DDMA) towards meeting expenses for emergency response, relief, and rehabilitation by the guidelines and norms laid down by the Government of India and the State Government.

#### Funding in Local Disasters

- A State Government **may use up to 10 per cent of the funds** available under the SDRF for providing immediate relief to the victims of natural disasters that they consider to be 'disasters' **within the local context in the State** and which are not included in the notified list of disasters of the Ministry of Home Affairs.
- This provision is subject to the condition that the State Government has listed the State-specific natural disasters and notified clear and transparent norms and guidelines for such disasters with the approval of the State Authority, i.e., the State Executive Committee (SEC).

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**IGNITE YOUR MIND**

As India confronts an array of natural and man-made disasters, the National Disaster Response Fund (NDRF) emerges as a crucial financial instrument aimed at catalyzing prompt and effective responses. Can you Propose some innovative financial instruments and collaborative frameworks that empower the NDRF?

## MITIGATION FUND

- **Formation:** In 2021 The Central Government constituted the **National Disaster Mitigation Fund (NDMF).** The Government also advised all the State Governments to set up State Disaster Mitigation Funds (SDMFs). As of March 2023, 25 States have initiated the setting up of SDMF. For SDMF, an amount of Rs. 32,031 crore has been allocated for the period 2021-22 to 2025-26 by the Finance Commission.
- **Funding:** The corpus of SDMF is contributed by the Government of India and the State Government in the ratio 75:25 for all States, except for the North-Eastern and Himalayan (NE&H) States, for which it is contributed 90:10.

## RECOMMENDATION OF THE 15TH FINANCE COMMISSION

15th Finance Commission (FC) placed significant emphasis on strengthening Disaster Risk Management (DRM) in India through its recommendations for the period 2021-26. These recommendations aim to shift the focus from post-disaster relief to pre-disaster preparedness and mitigation, building long-term resilience against natural hazards.

### Key Recommendations of the 15th FC on Disaster Management

- **New Methodology** adopted by 15th FC for allocations of funds to the States.
  - **Historical Approach:** Successive Finance Commissions up to 14th FC traditionally relied on an expenditure-based approach to determine fund allocations for Disaster Management to State Governments. The 15th Finance Commission has introduced a novel methodology for allocating funds to the States for Disaster Management.
  - **Components of New Methodology:** The new methodology combines three key factors:
    - **Capacity:** Reflected through past expenditure.
    - **Risk Exposure:** Considering the area and population.
    - **Hazard & Vulnerability:** Utilizing the disaster risk index.
- The commission proposed the formation of the **National Disaster Risk Management Fund** (**NDRMF**) and **State Disaster Risk Management Fund** (**SDRMF**) at the National Level and State Levels respectively.
  - NDRMF will consist of the National Disaster Response Fund and National Disaster Mitigation Fund and similarly, SDRMF will consist of the State Disaster Response Fund and State Disaster Mitigation Fund.
- From the total earmarked grants for Disaster management for both National and State Corpus **20% is earmarked for Mitigation and the remaining 80% for response funds.**
- **The Response fund has been further apportioned into three windows:**

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**Changes In Funding Structure Under 15th Finance Commission**

| Funding Windows | Allocation Percentage | Purpose |
|---|---|---|
| Response & Relief | 40% | Disaster response refers to the actions taken directly after a destructive event occurs |
| Recovery & Reconstruction (NDRMF/SDRMF) | 30% | Shift in focus to address recovery and reconstruction needs, rebuilding assets and livelihoods |
| Preparedness & Capacity Building (NDRMF/SDRMF) | 10% | Allocation to enhance states' preparedness for effective disaster response, supporting SDMAs, SIDM, training, capacity building, and emergency response facilities |
| Note: 1. NDRMF- National Disaster Risk Management Fund* 2. SDRMF- State Disaster Risk Management Fund* 3. SDMA- State Disaster Management Authority 4. SIDM- State Institute Of Disaster Management | | |



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## Why is This Division Introduced?

- **Preparedness:** State Governments require effective disaster preparedness to respond adequately to disasters. Their institutions and facilities must be well-equipped and functioning to handle emergencies.
- **Recovery & Reconstruction:** Recovery is vital for development, offering an opportunity for rebuilding infrastructure, reviving livelihoods, and improving civic services. The current guidelines for the National Disaster Response Fund (NDRF) and State Disaster Response Fund (SDRF) primarily focus on response and relief, **offering limited support for recovery and reconstruction.**

## Six Earmarked Allocations

The FC included six allocations which are aimed at addressing specific critical areas. The allotted amount will be spent on preparedness, mitigation, and recovery through special initiatives. A total of ₹11950 crores has been given in these six earmarked areas.

DISTRIBUTION OF TOTAL NATIONAL ALLOCATION (IN CRORES)

| | | | |
|---|---|---|---|
| NDMF (20%) | | | 13693 |
| Catalytic Assistance (12 most drought-prone States) | | 1200 | |
| Reducing Risk of Urban Flooding (7 most populous cities) | | 2500 | |
| Managing Seismic & landslide risk (10 hill States) | | 750 | |
| Mitigation measures to prevent erosion | | 1500 | |
| NDRF (80%) | | | 54770 |
| **Response & Relief (40%)** | | **27385** | |
| **Recovery & Reconstruction (30%)** | | **20539** | |
| **Preparedness & capacity building (10%)** | | **6846** | |
| Resettlement of displaced people affected by erosion | 1000 | | |
| Expansion & modernization of fire services | 5000 | | |
| Total NDRMF (NDMF + NDRF) | | | 68463 |

**Fig. 7.1:** 15th FC allocation in the National Disaster Risk Management Fund

1. **Expansion and Modernization of Fire Services:** Strengthening fire services across the country to improve response capabilities and save lives during fire emergencies.
2. **Catalytic Assistance to Twelve Most Drought-Prone States:** Supporting drought-prone states like Rajasthan, Andhra Pradesh, and Karnataka in implementing sustainable water management practices and mitigating the impact of droughts.
3. **Managing Seismic and Landslide Risks in Ten Hill States.**
4. **Reducing the Risk of Urban Flooding in Seven Most Populous Cities:** Implementing flood control measures and drainage systems in cities like Mumbai, Chennai, and Kolkata vulnerable to urban flooding.
5. **Mitigation Measures to Prevent Erosion:** Addressing soil erosion through afforestation, land terracing, and other initiatives to prevent environmental degradation and landslides.
6. **Resettlement of Displaced People Affected by Erosion:** Providing alternative settlements and rehabilitation support to communities displaced by coastal erosion, riverbank erosion, and other land degradation events.

STATE DISASTER RISK MANAGEMENT FUND (SDRMF) (IN CRORES)

| | | |
|---|---|---|
| SDMF (20%) | | 32031 |
| SDRF (80%) | | 128122 |
| **Response & Relief (40%)** | **64061** | |
| **Recovery & Reconstruction (30%)** | **48046** | |
| **Preparedness & capacity building (10%)** | **16015** | |
| Total (SDRMF) | | 160153 |

**Fig. 7.2:** 15th FC allocation in State Disaster Risk Management Fund

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## Cost-Sharing Arrangement (Between Center & States)

- **Central Assistance Structure:** Central assistance is provided through the National Disaster Response Fund (NDRF) or the National Disaster Mitigation Fund (NDMF) is structured on a cost-sharing basis.
- **Graded Cost-Sharing:** The cost-sharing arrangements follow a graded structure to ensure fairness and financial responsibility.
  - For assistance up to Rs. 250 crores, states are required to contribute 10 per cent.
  - Assistance up to Rs. 500 crores necessitates a state contribution of 20 per cent.
  - Contributions increase to 25 per cent for all assistance exceeding Rs. 500 crores from the NDRF or NDMF.
- **Preventing Exorbitant Demands:** This cost-sharing arrangement serves as a preventive measure against exorbitant financial demands from states, discouraging any competitive populism in the allocation of disaster relief funds.

## Alternate Sources of Funding Recommended by the 15th FC

In numerous instances, the funding allocated by the SDRF and NDRF is likely to prove inadequate. In such scenarios,



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both the Union and State Governments may encounter limitations in procuring disaster funds solely from these sources. Therefore, it becomes imperative for governments to explore **additional avenues for mobilizing financial resources, such as the issuance of reconstruction bonds, the establishment of contingent credit or standby facilities in collaboration with international financial institutions, the utilization of crowdfunding platforms, and leveraging corporate social responsibility initiatives.** Anticipatory development of these financial mechanisms and instruments is crucial, as it enables governments to identify and opt for more cost-effective solutions.

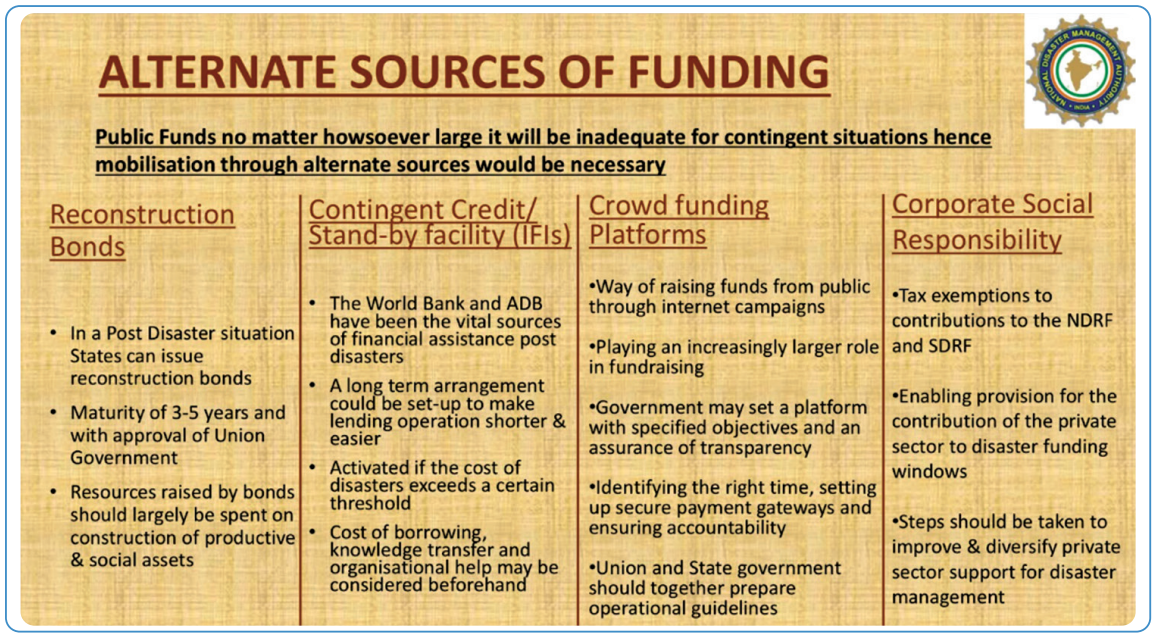


**Fig. 7.3:** Alternate Sources of Funding Recommended by 15th Finance Commission

## Other Recommendations of the 15th Finance Commission

- **Annual Report:** Generate an annual national-level report detailing all allocations, expenditures, key achievements, and results against various Sendai Framework for Disaster Risk Reduction (SFDRR) indicators.
- **Dedicated Capacity and Online System:** Allocate dedicated capacity for managing the National Disaster Risk Management Fund (NDRMF) and State Disaster Risk Management Fund (SDRMF), emphasizing the purpose of utilisation. Set up an online system for the release of fund allocations, expenditures, and outstanding balances for each state.
- **Two-Stage Assessment for NDRF Allocation:** Conduct a two-stage assessment for NDRF allocation:
  - First assessment to ascertain humanitarian and relief needs.
  - Second assessment to cover damage, loss, and recovery needs.
- **Post Disaster Needs Assessment (PDNA):** Utilize the Post Disaster Needs Assessment (PDNA) as a standard methodology for post-disaster assessments.
- **Disaster Database Establishment:** Establish a Disaster Database as a special initiative. Include disaster assessments, fund allocation details, expenditures, preparedness, and mitigation plans in the database.
- **Assistance to Women Members of Households:** Disburse assistance to women members of households, ensuring cash assistance is transferred in a way that provides women access to funds.

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## OTHER FUNDS

| PM National Relief Fund(1948) | PM Cares Fund(2020) |
|---|---|
| ❑ The Prime Minister's National Relief Fund (PMNRF) was established entirely with public contributions and **does not get any budgetary support.**<br>❑ PMNRF accepts **voluntary contributions** from Individuals, Organizations, Trusts, Companies and Institutions etc. | ❑ Keeping in mind the need for **having a dedicated fund with the primary objective of dealing with any kind of emergency or distress situation, like posed by the COVID-19** pandemic, and to provide relief to the affected, a public charitable trust under the name of 'Prime Minister's Citizen Assistance and Relief in Emergency Situations Fund (PM CARES Fund)' has been set up in 2020. |



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| | |
|---|---|
| ❑ The resources of the PMNRF are **now utilized primarily to render immediate relief to families of those killed in natural calamities like floods, cyclones, earthquakes, etc. and to the victims of the major accidents and riots.**<br>❑ The corpus of the fund is invested in various forms with scheduled commercial banks and other agencies.<br>❑ Disbursements are made with the approval of the Prime Minister.<br>❑ PMNRF has **not been constituted by the Parliament.**<br>❑ The fund is **recognized as a Trust under the Income Tax Act** and the same is managed by the Prime Minister or multiple delegates for national causes.<br>❑ **Donations to the Fund would qualify for 80G benefits for 100% exemption under the Income Tax Act, of 1961.**<br>❑ It will also qualify to be counted as a Corporate Social Responsibility (CSR) expenditure under the Companies Act, 2013. | ❑ The fund consists **entirely of voluntary contributions** from individuals/organizations and does not get any budgetary support.<br>❑ PM CARES Fund has been exempted under FCRA and can accept foreign donations. **This is consistent with PMNRF, which has received foreign contributions since 2011.**<br>❑ **Donations to the PM CARES Fund would qualify for 80G benefits for 100% exemption under the Income Tax Act, of 1961.**<br>❑ It will also qualify to be counted as Corporate Social Responsibility (CSR) expenditure under the Companies Act, 2013. |

# DISASTER MANAGEMENT CAPACITY BUILDING

Capacity building is an ongoing process that equips officials, stakeholders and the community to perform their functions in a better manner during a crisis/disaster. In the process of capacity building the administration should include elements of **human resource development,** i.e., individual training, organizational development such as improving the functioning of groups and organizations and institutional development. At the national level, The **National Institute of Disaster Management (NIDM) is the capacity-building arm and the States have disaster management cells in the State Administrative Training Institutes that perform the function of capacity-building for effective and efficient disaster management.** There are a number of other training institutes which are engaged in training and capacity building in the area of disaster management.

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## Goals of Capacity Building

- **Competence** to **respond** to disasters in time and effectively.
- Competence to ensure that **development programmes and projects do not create new disaster vulnerabilities.**
- Competence to **undertake effective disaster mitigation measures.**
- Competence to reconstruct better than before.
- Competence to engage in recovery as an opportunity for improved and inclusive development.
- **Capacity to identify resilience features and build resilience**
- **Ability to link with development, climate change and disaster risk reduction**
- **Recognition of transboundary risks and building capacity**
- Ability to identify new emerging local challenges –climate change, pandemic, heat wave, cold wave, coastal erosion etc.

## Capacity Building Role and Responsibilities in India

- To **develop parameters/guidelines** under which NIDM has to function.
- **International Cooperation** including preparation/ finalization of MoUs in the field of disaster management with various countries, and their implementation, visits of foreign delegations for bilateral meetings, etc.
- To **coordinate with International Organizations** such as UNDRR, UNDP, UNICEF, UNOCHA, UNFPA, IORA, BRICS, SCO, BIMSTEC, ADPC, ADRC, G20, World Bank, SAARC, ASEAN, etc.
- Nomination of officers of NDMA as guest lecturers or participants for attending International and National Workshops / Seminars / Training / Meetings, Forums / etc.
- **Implementation of various projects of Capacity Building** on Disaster Management (DM), DRR, and Disaster Response in collaboration with State governments/ UTs and Centre for Disaster Management, LBSNAA, Mussoorie.
- **Monitoring of implementation of the National Disaster Management Guidelines on School Safety Policy** – 2016 in all schools of India.
- Monitoring of DM Exhibition & Mock Drills in all Schools of AMRUT Cities (500).
- Processing of proposals of partial financial support for organizing events on disaster-related subjects receives various Departments of GoI/State Govts. and Institutions such as IITs, JNU, FICCI, CII, TIFAC and NGOs etc.

## Efforts By NDMA For Capacity Building

### At the Policy and Plan Level

- **Strengthening of SDMA/DDMA:** The NDMA executed the 'Strengthening of State Disaster Management Authorities (SDMAs) and District Disaster Management



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Authorities (DDMAs)' scheme, investing Rs. 42.5091 crores from June 1, 2015, to March 31, 2018. The initiative aimed to enhance disaster management in 28 states and 6 Union Territories through MoUs, excluding Tamil Nadu and Delhi.

- **National Platform for DRR:** The Government of India acknowledges the importance of inclusive decision-making in disaster management, leading to the establishment of the National Platform for Disaster Risk Reduction (NPDRR) in 2013. Chaired by the Union Home Minister, it includes various stakeholders, fostering dialogue, sharing experiences, and promoting cooperation in Disaster Risk Reduction.
- **Sustainable Reduction in DR:** In collaboration with five states – Assam, Bihar, Jammu & Kashmir, Himachal Pradesh, and Uttarakhand – NDMA executed the "Sustainable Reduction in Disaster Risk" project from June 2016 to March 2020. The initiative aimed to enhance community and local self-government preparedness in 10 vulnerable districts. Activities included forming DM Teams, conducting workshops, updating disaster management plans, and organizing awareness programs and mock drills.

### Mitigation Level Capacity Building Measures

- **Incident Response System**
  - **About:** The Incident Response System (IRS) is an effective mechanism for reducing ad-hoc measures in response. It envisages a composite team with various Sections to **attend to all the possible response requirements**. It also emphasizes the need for proper documentation of various activities for better planning, accountability and analysis.

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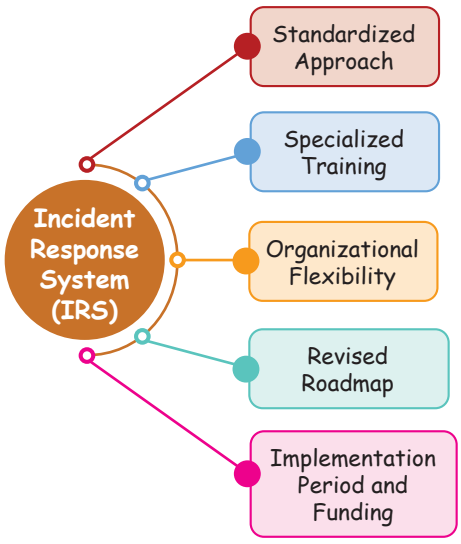


**Fig 7.4:** Features of Incident Response System

  - **Purpose:** This will greatly help in reducing chaos and confusion during the response phase. Everyone will know what needs to be done, who will do it and who is in command.
  - **Legal status:** The National Disaster Management Authority (NDMA) has issued the Guidelines on the Incident Response System (IRS) under Section 6 of the DM Act, 2005 for effective, efficient and comprehensive management of disasters in India. The vision is to minimize loss of life and property by strengthening and standardizing the disaster response mechanism in the country.
- **Mock Exercises:** To instil a preparedness mindset in communities and first responders, NDMA, in collaboration with vulnerable states, initiated Mock Exercises. These exercises aim to assess and improve disaster management plans, identify resource gaps, and enhance awareness.
- **Common Alerting Protocol Based Integrated Alert System (Sachet):** It aims for rapid disaster alert dissemination. It integrates Alert Generating Agencies (IMD, CWC, etc.), Alert Disseminating Agencies (TSPs, TV, Social media, etc.), and Disaster Management Authorities, monitored nationally and at the state level. NDMA funds this project, with Pan India implementation sanctioned after a successful Tamil Nadu pilot. **The Center for Development of Telematics (C-DOT) is executing the project until March 31, 2024.**
- **Trauma Care:** In partnership with Jai Prakash Narayan Apex Trauma Centre (JPNATC), NDMA conducted a pilot Advanced Trauma Life Support project from May 2012 to May 2013, training medical professionals in trauma care, initially focusing on vulnerable states.
- **Chemical, Biological, Radiological and Nuclear Emergencies:** NDMA implemented a **"Mobile Radiation Detection System"** project, equipping and training police personnel in select cities to manage radiological emergencies in public spaces. The project provides PPEs and radiation detectors, including vehicle-mounted Go-NoGo meters.

### At Administration & Coordination Level

- **NDMA –IGNOU Pilot Project:** In partnership with IGNOU, NDMA executed a pilot project for capacity building in disaster management for Government Officials, Panchayati Raj Institutions, and Urban Local Bodies. This involved conducting 8 Face-to-Face Training Programs across 54 districts in 11 hazard-prone states.
- **Lal Bahadur Shastri National Academy of Administration:** In collaboration with the Centre for Disaster Management, LBSNAA, Mussoorie, NDMA conducts a pilot project to train IAS/Central Service officers in disaster management.

## Capacity Gaps In Disaster Management

- **Policy level:** Policy-level capacity gaps in disaster management may include insufficient integration of DRR concepts, inadequate legal frameworks, limited



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coordination mechanisms, and a lack of comprehensive policies addressing emerging threats.

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Imagine being trapped in the darkness and silence for 17 days. How would that experience change your perspective on life, risk, and human connection?

- **Management level:** Management-level capacity gaps in disaster management include insufficient coordination, limited decision-making skills, inadequate communication strategies, and challenges in implementing comprehensive and effective response plans.
- **Operational level:** Operational-level capacity gaps in disaster management include inadequate training, insufficient resources, coordination challenges, and limited preparedness measures, hindering effective response and recovery efforts during emergencies.

### Empowering Panchayati Raj Institutions for Disaster Preparedness and Management

- **Current Challenges:** Government agencies currently bear sole responsibility for disaster management, limiting local participation and community resilience. This centralized approach increases dependence on the government and hinders effective disaster preparedness at the local Gram Panchayat level.
- **Need for Local Capacity Building:** Immediate disaster response often faces delays due to formalities, resulting in significant damage. Building local capacity at the Gram Panchayat level is essential, necessitating a shift from the current top-down approach to a more efficient, effective system.
- **Crucial Role of Panchayats:** Recognizing the vital role of panchayats, the Commission emphasises making them the nodal agency for relief and rehabilitation. This can enhance planning, coordination, and monitoring, improving overall disaster intervention.
- **Proactive Involvement in Disaster Management:** Panchayati raj institutions can proactively engage in all aspects of disaster management, including prevention, mitigation, preparedness, response, restoration, rehabilitation, and reconstruction. Their involvement is crucial in activities like rescue operations, relief distribution, and risk mitigation.
- **Financial Mechanisms and Decentralized Approach:** The Commission suggests State Governments allocate a reasonable amount from the SDRF and SDMF to districts, promoting a decentralized approach to disaster management. While acknowledging challenges in resource allocation, empowering panchayats remains a cornerstone in effective disaster management.

## Challenges In Disaster Management Capacity Building

- **Resource Constraints:** Limited funding and resources hinder comprehensive training programs.
- **Rapidly Changing Nature of Disasters:** Evolving threats like extreme weather events, heat waves, and biological disasters demand continuous updates to training. **Example:** COVID-19 highlighted the need for adaptable training programs.
- **Community Engagement:** Involving communities face obstacles like cultural differences. **Example:** Local workshops involving residents in risk identification may be hindered by language barriers.
- **Climate Change Complexity:** Increasing climate-related disasters require adaptive capacity building. **Example:** Monsoon Mayhem, 2023 in India demanded a high degree of capacity to handle the disaster.

## Way Forward

- **Mainstreaming Disaster Risk Reduction into Development:** Regularly assess risks to inform land-use planning, infrastructure development, and livelihood programs, prioritizing risk reduction and resilience building. Support initiatives that build infrastructure and develop livelihoods that can withstand the impacts of climate change and natural disasters.
- **Advocating for Risk-informed Policies and Legislation:** Advocate for policies that mandate DRR measures, establish accountability for preparedness and response, and promote risk-informed development. Campaign for dedicated disaster preparedness budgets and international assistance programs to ensure access to resources for capacity building.
- **Empowering Youth and Marginalized Groups:** Actively engage youth and marginalized communities in DRR planning and implementation through inclusive and participatory approaches. Design programs that address the specific needs and vulnerabilities of women, children, persons with disabilities, and other marginalized populations.
- **Investing in Resilient Infrastructure and Early Warning Systems:** Analyze potential threats and vulnerabilities to inform critical infrastructure upgrades (e.g., roads, bridges, communication networks) for improved disaster resistance. Utilize technology to establish accessible and effective early warning systems tailored to local hazards, ensuring timely and clear communication of warnings.
- **Fostering Inter-institutional Collaboration and Coordination:** Build strong relationships between government agencies, NGOs, the private sector, and academia to facilitate resource sharing, expertise exchange, and joint planning. Clearly delineate the roles

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and responsibilities of all stakeholders at local, regional, and national levels to ensure a coordinated and efficient response.

- **Localized, Culturally Relevant Education and Awareness:** Brochures, infographics, and workshops focusing on prevention, early warning systems, and emergency preparedness should be tailored to local contexts and translated into relevant languages. Employ radio, local media, mobile apps, and community-based training sessions led by trusted local voices to reach all demographics effectively.
- **Empowering Local Leadership and Volunteer Networks:** Equip trusted individuals with skills in disaster preparedness and response leadership to spearhead local initiatives. Build a network of volunteers trained in first aid, search and rescue, evacuation, and basic needs distribution to provide immediate support during disasters.

## CONCLUSION

India's journey towards disaster resilience hinges on robust capacity building. Investing in training, research, and early warning systems will empower communities and institutions to anticipate, prepare for, and respond effectively to disasters. Building resilient infrastructure, coupled with community engagement and financial preparedness will further enhance the government's proactive approach, safeguarding lives and livelihoods in the face of inevitable hazards.

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# International Cooperation

# 8

## INTRODUCTION

India has played an important role in global initiatives on disaster management. With multi dimensional initiatives and expertise, India is taking a leading role in strengthening regional cooperation among South Asian countries for reducing disasters, furthermore, it has hosted the SAARC Disaster Management Centre in New Delhi. Committed to the Hyogo Framework of Action, India diligently works towards achieving the goals set under it through systematic and sustained efforts under the five priority action areas mentioned in the framework. This demonstrates India's dedication to global and regional disaster management in a more concise manner.

## HYOGO FRAMEWORK OF ACTION

In January 2005, a global conference on Disaster Risk Reduction took place in Kobe, Japan, drawing representatives from 168 countries. During this event, the Hyogo Framework of Action (HFA) 2005-2015 was adopted to work globally towards sustainable reduction of disaster losses in lives and in the social, economic and environmental assets of communities and countries. The framework outlined **three strategic goals** and identified **five priority action areas:**

**Three Strategic Goals**

1. **Enhanced Integration into Sustainable Development:** The primary objective under the HFA involves more effectively integrating disaster risk reduction into sustainable development policies, planning, and programming across all levels, with a special emphasis placed on prioritizing disaster prevention, mitigation, preparedness, and vulnerability reduction.

2. **Institutional Development and Capacity Strengthening:** A key goal is the development and reinforcement of institutions, mechanisms, and capacities at all levels, particularly at the community level. The aim is to systematically contribute to building resilience to hazards within communities.

3. **Incorporation of Risk Reduction in Emergency Programs:** The HFA underscores the systematic incorporation of risk reduction approaches into the design and implementation of emergency preparedness, response, and recovery programmes during the reconstruction of affected communities.

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**Fig. 8.1:** Three Strategic Goals of Hyogo Framework

### Five Priority Action Areas

1. **National and Local Priority for Disaster Risk Reduction:** Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.
2. **Risk Identification, Assessment, and Monitoring:** Countries are encouraged to focus on identifying, assessing, and monitoring disaster risks, while also enhancing early warning systems to improve preparedness.
3. **Knowledge, Innovation, and Education for Safety Culture:** The HFA advocates for the utilization of knowledge, innovation, and education to foster a culture of safety and resilience at all levels within communities and nations.
4. **Addressing Underlying Risk Factors:** Efforts should concentrate on reducing the underlying risk factors that contribute to the vulnerability of communities to disasters.
5. **Strengthening Disaster Preparedness:** **Strengthen disaster preparedness for effective response at all levels.**

**Fig. 8.2:** Five Priority Action Areas under the Hyogo Framework

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## Key Initiatives Based on Priority Action of Hyogo Framework for Disaster Reduction

| Country/Region | Key Initiatives based on Priority Action of Hyogo Framework for Disaster Reduction | Challenges Encountered |
|---|---|---|
| Madagascar | **Make Disaster Risk Reduction a Priority:** Madagascar has established a National Platform for Disaster Reduction, fostering collaboration among government departments, NGOs, media, donors, and the UN. This platform conducts training, enhances preparedness through cyclone refuges, and is finalizing an Early Warning System. There is an ongoing effort to integrate disaster risk reduction with poverty reduction in the Poverty Reduction Strategy Paper (PRSP). Noteworthy achievements include improved preparedness with cyclone refuges. | Challenges may arise in coordinating diverse stakeholders effectively. |
| Cuba | **Know the Risks and Take Action:** Cuba excels in hurricane preparedness with a sophisticated Early Warning System. Alerts are issued 72 hours before a storm, evacuation plans are checked 48 hours before landfall, and targeted warnings are issued 12 hours before. Success stories include effective evacuations during hurricanes Charley and Ivan in 2004, resulting in zero casualties during the latter. | Continuous maintenance of the Early Warning System is crucial for sustained success. |
| Simeulue (Indonesia) | **Build Understanding and Awareness:** Residents of Simeulue showcase the power of local knowledge for disaster preparedness. Passed down through generations, early warning signs of natural hazards are imparted within communities. Success stories include minimal casualties (seven people) during the Indian Ocean tsunami. | Challenges may include ensuring the continuity of passing down local knowledge to future generations. |
| Bam, Iran | **Reduce Risk:** Building resilience is prioritized in Bam, Iran, to mitigate the impact of unsafe buildings and lax building codes. The devastating 2003 earthquake underscored the importance of safe buildings. Success stories include heightened awareness of safe construction practices. | Challenges involve enforcing stricter building codes to prevent significant loss of life and property. |
| Japan | **Be Prepared and Ready to Act:** Japan prioritizes disaster preparedness with an annual Disaster Prevention Day involving the public and emergency workers nationwide drills. Success stories include Japan's reputable earthquake preparedness. | Challenges including the ongoing need for regular practice and continuous improvement in disaster preparedness. |

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## SENDAI FRAMEWORK

The Sendai Framework for Disaster Risk Reduction 2015-2030, a **landmark agreement within the post-2015 development agenda**, offers Member States tangible strategies to safeguard development achievements **against the threat of disasters.** It puts in place 4 clear priorities for action and 7 global targets for the substantial reduction of disaster risk.

- **Endorsement and Origin:** It has been endorsed by the **UN General Assembly after the 2015 Third UN** World Conference on Disaster Risk Reduction **(WCDRR)**
- **Goal:** To prevent new disasters and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience.

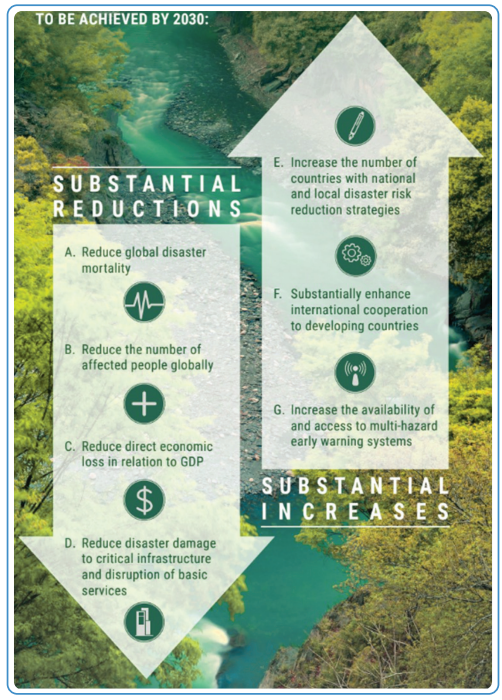


Fig. 8.3: Targets of Sendai Framework



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- **Upgrade From Hyogo:** The Sendai Framework **covers technological hazards, in addition to natural hazards,** which represent an evolution compared to its predecessor, the Hyogo Framework for Action. These technological hazards include chemical/industrial hazards further to radiological, nuclear, biological, and others.
- **Integration with 2030 Agenda:** The Sendai Framework collaborates seamlessly with other 2030 Agenda agreements, such as The Paris Agreement on Climate Change, The Addis Ababa Action Agenda on Financing for Development, the New Urban Agenda, and ultimately the Sustainable Development Goals.
- **Shared Responsibility:** It recognizes that the State has the primary role to reduce disaster risk but that responsibility should be shared with other stakeholders including local government, the private sector and other stakeholders.

## Four Priority Themes of the Sendai Framework

1. **Understanding disaster risk:** Disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment. Such knowledge can be used for risk assessment, prevention, mitigation, preparedness and response.
2. **Strengthening disaster risk governance to manage disaster risk:** Disaster risk governance at the national, regional and global levels is very important for prevention, mitigation, preparedness, response, recovery, and rehabilitation. It fosters collaboration and partnership.
3. **Investing in disaster risk reduction for resilience:** Public and private investment in disaster risk prevention and reduction through structural and non-structural measures is essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment.
4. **Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction**
   The growth of disaster risk means there is a need to strengthen disaster preparedness for response, take action in anticipation of events, and ensure capacities are in place for effective response and recovery at all levels. The recovery, rehabilitation and reconstruction phase is a critical opportunity to build back better, including through integrating disaster risk reduction into development measures.

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**Fig. 8.4:** Four Priority Themes of Sendai Framework

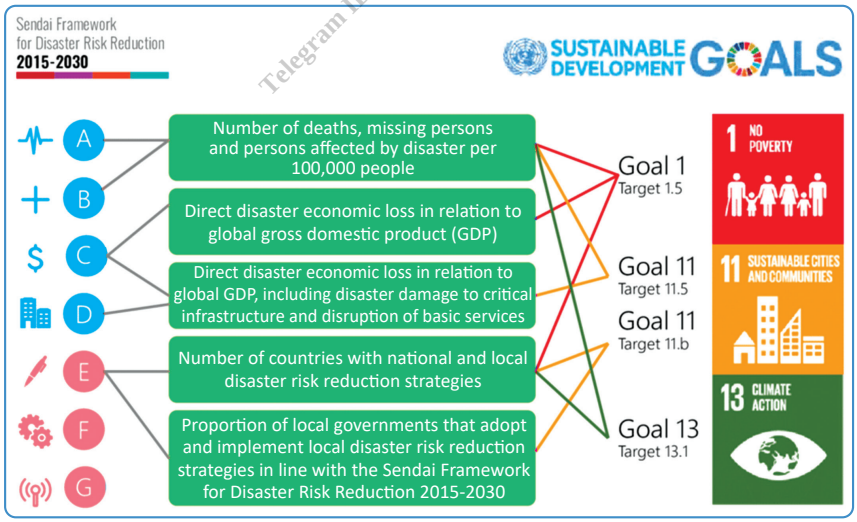


**Fig. 8.5:** Link between Sendai Framework 7 Targets and SDGs

## Actions Taken By India for Sendai Framework

- **Increased Funding for Disaster Risk Reduction:** India has prioritized disaster risk reduction, significantly boosting funding. Approximately $6 billion is allocated for risk mitigation (2021-2025), with an additional $23 billion for preparedness, response, and recovery.
- **Landmark Changes in Financing:** India implemented financing changes, addressing the full spectrum of disaster risk management needs. State and local governments now access substantial funds for enhanced capabilities.
- **Success in Reducing Loss of Lives:** India reduced cyclone-related fatalities to under 2% in a decade. Ambitious



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programs target further risk reduction from various hazards.

- **Early Warning System Improvements:** The **Common Alerting Protocol** integration enhances early warning systems, reaching all 1.3 billion citizens with geo-targeted alerts in regional languages.
- **G20 Working Group and Priorities:** India, as G20 president, established a Working Group on Disaster Risk Reduction. Priorities include early warning, resilient infrastructure, improved financing, response capacities, and ecosystem-based approaches.
- **Coalition for Disaster Resilient Infrastructure:** Co-leading with the U.S., India drives transformation in infrastructure planning, design, and construction for long-term resilience.
- **Humanitarian Assistance and Global Cooperation:** India exemplifies global cooperation by providing swift assistance to Turkiye and Syria after recent disasters. This aligns with SDGs, emphasizing global unity.

**Difference Between the Hyogo Framework and Sendai Framework**

| Aspect | Hyogo Framework (HFA) | Sendai Framework |
|---|---|---|
| Time Frame | 2005-2015 | 2015-2030 |
| Global Conference Origin | Second UN World Conference on Disaster Risk Reduction (2005), Kobe, Japan | Third UN World Conference on Disaster Risk Reduction (2015), Sendai, Japan |
| Strategic Goals | **Three goals,** including integration into sustainable development | Emphasizes substantial reductions in disaster risk |
| Priority Action Areas | **Five areas,** e.g., national and local priorities, risk identification | **Four themes:** understanding risk, improving governance, investing in reduction, preparedness and early warning |
| Integration with Development Agendas | Advocated for integration into sustainable development policies | Seamless integration with various 2030 Agenda agreements (Paris Agreement, Addis Ababa Action Agenda, New Urban Agenda, SDGs) |
| Responsibility Emphasis | Emphasized integrating disaster risk reduction into development policies | Acknowledges state's primary role but emphasizes shared responsibility |
| Humanitarian Assistance and Global Cooperation | No specific details provided | Exemplifies global cooperation through humanitarian assistance aligning with SDGs |

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## Post Sendai Initiatives

In alignment with its commitment to the Sendai Framework, the Government of India has undertaken significant initiatives to strengthen disaster risk reduction and response strategies.

- **Hosting of AMCDRR 2016 and Commitments:** The Asian Ministerial Conference on Disaster Reduction (AMCDRR), held in November 2016 in India marked a pivotal step. The adoption of the 'New Delhi Declaration' and the 'Regional Action Plan for Implementation of the Sendai Framework' demonstrated collective commitment in the Asia-Pacific region. Outcomes from AMCDRR will guide the implementation of the Sendai Framework.
- **Priority Actions and Financial Support:** The Government issued a set of priority actions aligned with the Sendai Framework's goals to all State Governments. During the Asian Ministerial Conference on Disaster Reduction (AMCDRR) 2016, India extended a grant of US $1 million to the United Nations Office for Disaster Risk Reduction (UNISDR) to effectively implement the Sendai Framework in the Asian region.
- **Strengthening National Disaster Response Force (NDRF):** Recognizing the importance of a robust response force, the NDRF has been strengthened through state-of-the-art training and equipment enhancements. The creation of the National Disaster Response Reserve (NDRR) with a dedicated fund of Rs.250 crore (2020) further empowers the NDRF to maintain essential emergency goods and services.
- **Regional Cooperation and Knowledge Sharing:** India's commitment to regional cooperation is evident through initiatives such as hosting the SAARC Disaster Management Centre and participation in the **SAARC Disaster Management Exercise (SAADMEX)** 2015. Efforts to share expertise, particularly after the Japan Earthquake in 2011 and the Nepal earthquake in 2015, reflect India's commitment to disaster response collaboration.
- **Capacity Building and Institutional Strengthening:** Efforts to augment capacity building include collaborations with institutions like Jawaharlal Nehru University for the establishment of a Centre for Excellence in Disaster Research and Resilience Building. The formation of the National Disaster Response Force Academy and the allocation of funds for infrastructure development training underscore India's commitment to mainstreaming Disaster Risk Reduction (DRR).



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### The Nairobi Declaration (2021)

The Nairobi Declaration, adopted by African ministers and heads of delegations on November 19, 2021, emphasized the need to deliver commitments on the Programme of Action (PoA) for implementing the Sendai Framework for Disaster Risk Reduction (SFDRR), 2015-2030. The PoA outlines how Africa aims to implement SFDRR on the continent.

## ASIAN MINISTERIAL CONFERENCE ON DISASTER REDUCTION (AMCDRR)

**The conference was Hosted** by India in November 2016 and resulted in the adoption of the 'New Delhi Declaration and 'Regional Action Plan for Implementation of the Sendai Framework.' Here the Prime Minister of India presented a **10-point agenda** on Disaster risk reduction.

- **All development sectors must imbibe the principles of disaster risk management:** It basically means that Development should focus on reducing disaster risks and not creating them.
- **Work towards risk coverage for all starting from poor households to SMEs to multinational corporations to nation-states:** In this context, there is a need for the development of disaster insurance mechanisms for home-owners in disaster-prone area, parametric insurance for weather and climate-related disasters, and insurance products to cover major infrastructure projects
  - The government has some schemes having risk coverage in consideration which include Jan Dhan Yojana, Suraksha Bima Yojana, Fasal Bima Yojana (crop insurance) etc.
- **Women's leadership and greater involvement should be central to disaster risk management:** We need a large number of women volunteers, engineers, masons and building artisans to participate in post-disaster reconstruction and promote women's Self Help Groups (SHGs) which can assist in livelihood recovery. There is a need to include women in NDRF and SDRF, and to train elected women representatives at the local level under development.
- **Invest in risk mapping globally:** With a shared understanding of the nature and severity of disaster risks globally, their impacts can be mitigated with better planning and preparedness. This requires undertaking multi-hazard risk assessments and developing maps for all major hazards in a standardized format to facilitate disaster risk reduction.
- **Leverage technology to enhance the efficiency of disaster risk management efforts:** This requires the use of technology in resource planning, e.g., India Disaster Resources Network (IDRN), the creation of e-platform to map expertise and resources on highly specialized aspects of disaster response and to increase the efficacy of early warning systems for all major hazards through the application of technology.
- **Build on local capacity and intiative:** Such efforts reduce risk and create opportunities for local development and sustainable livelihoods. Localization of disaster risk reduction will also ensure that good use is made of the traditional best practices and indigenous knowledge.
- **Ensure that the opportunity to learn from a disaster must not be wasted:** After every disaster there is a need to undertake research studies to understand the best practices and learn lessons to improve the policy and disaster governance.
- **Develop a network of universities to work on disaster-related issues**: It will be helpful to develop a network of universities and academic institutions to work on disaster-related aspects. As part of this network, different universities could specialize in multi-disciplinary research on disaster issues most relevant to them.
- **Utilize the opportunities provided by social media and mobile technologies for disaster risk reduction**: Social media is transforming disaster response, it is helping response agencies in quickly organizing themselves and enabling citizens to connect more easily with authorities.
- **Bring about greater cohesion in international response to disasters**: Disasters' impacts are huge and so are the needs to be prepared for and respond strategically. Across the globe, countries face disasters similar in nature and sometimes across the countries. It requires coordinated and unified response by affected countries.

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## COALITION FOR DISASTER RESILIENT INFRASTRUCTURE (CDRI)

CDRI was first proposed by Indian Prime Minister Narendra Modi during the 2016 Asian Ministerial Conference on Disaster Risk Reduction held in New Delhi. CDRI represents a collaborative effort involving national governments, United Nations programs and agencies, development banks, academic institutions, and the private sector. This partnership is dedicated to collectively addressing the challenges associated with integrating resilience into infrastructure systems and related developments.



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- **Core Objectives:**
  - **Resilience Advocacy:** The CDRI strives to advocate for the resilience of both new and existing infrastructure systems against climate and disaster risks, aligning to support sustainable development.
  - **Global Consultation:** With over 35 countries actively participating in consultations, the coalition seeks to achieve a measurable reduction in infrastructure losses from disasters on a global scale.
  - **SDG Alignment:** The CDRI aligns its efforts with the Sustainable Development Goals (SDGs), aiming to contribute to universal access to basic services, prosperity, and the creation of decent work.
- **Standardization and Regulation:** The coalition endeavours to standardize designs, processes, and regulations about infrastructure creation and management. This approach is geared towards enhancing the resilience of infrastructure systems.
- **Non-binding Nature:** It is essential to underscore that the CDRI operates as a partnership without imposing rights and obligations on its members. The decisions, policies, and standards set by the coalition are not binding on the participating nations.
- **Inauguration and Location:** It was launched by Prime Minister Modi in September 2019 at the UN Climate Action Summit, the CDRI's Secretariat is situated in New Delhi, India.
- **Platform for Knowledge Exchange:** Functioning as a platform for knowledge generation and exchange, the CDRI is committed to developing both country-specific and global plans to advance disaster-resilient infrastructure.
- **Support and Capacity Development:** The CDRI plays a pivotal role in providing member countries with technical support, capacity development, research, knowledge management, and advocacy. This comprehensive support framework aims to facilitate and enhance investments in disaster-resilient infrastructure systems.

### CDRI and Headquarters Agreement (HQA)

The Union Cabinet has approved the ratification of the Headquarters Agreement (HQA) between the Government of India (GoI) and the Coalition for Disaster Resilient Infrastructure (CDRI), signed on August 22, 2022. This approval enables the granting of exemptions, immunities, and privileges outlined in Section 3 of the United Nations (Privileges & Immunities) Act, 1947. By ratifying this agreement, the CDRI gains an independent and international legal status. This status allows it to function more efficiently on the global stage, carrying out its responsibilities with increased effectiveness. The agreement essentially establishes a framework for the CDRI to operate globally, enjoying certain legal benefits and protections.

## PARIS AGREEMENT (2015) AND DISASTER RISK MANAGEMENT

The Paris Agreement is a crucial global treaty designed to tackle climate change and enhance the world's ability to respond to its effects. It aims to keep global warming well below 2 degrees Celsius, ideally limiting it to 1.5 degrees Celsius compared to pre-industrial levels.

### Key Provisions for Disaster Management

- **Loss and Damage Framework:** The agreement acknowledges the irreversible losses and damages vulnerable nations are experiencing due to climate change. It establishes a framework for global cooperation to address these losses and aid in recovery efforts.
  - In November 2022 After intense negotiations at COP 27, representatives of the UNFCCC's member states agreed to set up the Loss & Damage fund.
- **Technology Transfer and Capacity Building:** Developed nations are encouraged to share technology and knowledge with developing countries. This support helps these nations adapt to climate change and build resilience to disasters.
- **Global Stocktake:** Every five years, countries gather to evaluate collective progress towards the agreement's goals. This includes assessing adaptation initiatives and strategies for reducing disaster risks.

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### Operationalisation of a Loss and Damage Fund

The COP28 climate conference in Dubai began on a promising note, approving one of the most keenly awaited decisions – the operationalisation of a loss and damage fund for developing countries – on the first day. About $475 million was immediately committed to the fund, with the European Union pledging nearly $275 million, and hosts UAE promising another $100 million.

### Paris Agreement and Disaster Risk Management

- **Call for Increased Coherence:** There is a clear mandate for heightened coherence in countries' approaches to climate and disaster risk reduction. Current interventions often operate in administrative silos, leading to missed synergies and duplicated efforts.
- **Shared Objectives:** Climate change adaptation (CCA) and disaster risk reduction (DRR) interventions inherently share common objectives like building resilience, reducing risk, and preparing for future climate impacts. Both aim to safeguard lives, infrastructure, and livelihoods from extreme weather events and slow-onset climate changes. However, they are frequently developed and implemented separately, hindering their potential impact.



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- **Government Recognition and Initiatives:** Governments are increasingly acknowledging the advantages of greater coherence in CCA and DRR. This recognition is evident in the development of joint strategies and the implementation of processes that facilitate coordination across these two policy areas.
- **Coherence between Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR):** This means working together to make communities stronger against both gradual climate changes and sudden disasters. It's like building a strong house and getting it ready for storms. Coherence uses the same tools and materials for both, so the house can withstand various challenges. Combining efforts for the best results saves time, money, and lives.

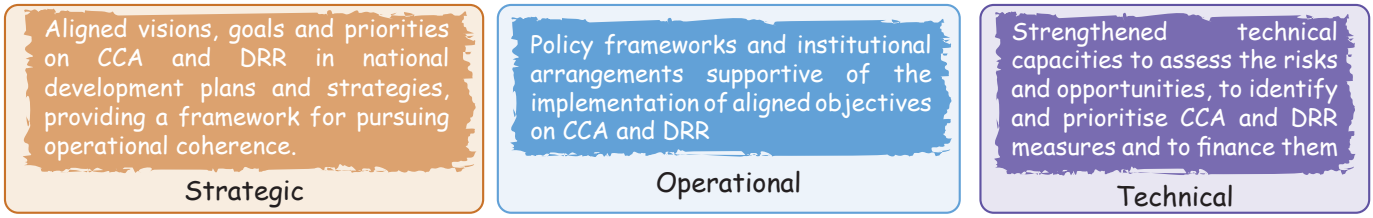


**Fig. 8.6:** Types of Coherence under Paris Agreement

## G20 DISASTER RISK REDUCTION WORKING GROUP

G20 nations confront significant exposure to disaster risks, with an estimated Annual Average Loss amounting to $218 billion. This constitutes a substantial 9% of their average annual investment in infrastructure. Although G20 Leaders have intermittently acknowledged the importance of disaster risk reduction and resilience in their declarations, a comprehensive and sustained focus on the issue has been lacking.

- **Establishment of the G20 Disaster Risk Reduction Working Group:** To remedy this gap, a new working group on Disaster Risk Reduction has been instituted under India's Presidency.
  - **Objective:** The primary objective is to cultivate collaborative endeavors among G20 countries, engage in multidisciplinary research, and facilitate the exchange of best practices in disaster risk reduction.
- **Rationale for the Working Group:** Recognizing the universal impact of disasters and the collective jeopardy they pose to our shared future, the establishment of the working group underscores the Presidency's commitment to the theme of **'Vasudhaiva Kutumbakam'** – 'One Earth, One Family, One Future.'
- **Priorities & Expected Outcomes:** Aligned with the overarching principles of the Sendai Framework for Disaster Risk Reduction, the proposed priorities for the G20 group of countries within the working group are as follows:
  - **Global Early Warning Systems:** It aims for global coverage of Early Warning Systems for all hydro-meteorological disasters.
  - **Infrastructure Resilience:** Increase commitment to making infrastructure systems disaster and climate-resilient.
  - **Financial Frameworks:** Strengthen national financial frameworks for disaster risk reduction.
  - **Disaster Response Systems:** Enhance national and global disaster response systems to effectively address the escalating frequency and intensity of disasters.
  - **Ecosystems-Based Approaches:** Encourage increased application of ecosystems-based approaches to disaster risk reduction.

### Contributions Made By India At G20

- Established G20 Working Group on DRR (2023)
- Embraced the theme of "One Earth, One Family, One Future"
- Advocated for community empowerment in recognizing vulnerabilities and preparing for disasters
- Encouraged G20 members to harness technology for more efficient preparedness and response strategies
- Called for robust international collaboration in research, knowledge sharing, and resource mobilization for DRR initiatives

## WORLD BANK'S EPIC FRAMEWORK

Hydro-climatic hazards, like floods and droughts, can be managed to prevent disasters. Despite progress in the last decades, the magnitude of the challenge is still not fully grasped. Over 2 billion people over the period 1995–2015 have been affected by floods and droughts, causing significant economic and social costs. Given the urgency of staying ahead of the changing climate, the World Bank, with support from Deltares, a Netherlands-based research institute, has put forward a new perspective to better manage these risks – the EPIC Response framework (Enable, Plan, Invest, Control).

The framework is being piloted by the World Bank-supported Assam Integrated River Basin Management Program. The program seeks to reduce the vulnerability of Assam's people to climate-related disasters and help the state develop its substantial water resources in an integrated and sustainable manner.



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**IGNITE YOUR MIND**

Could you think international non-governmental organizations (INGOs) can navigate the delicate balance between providing crucial disaster management assistance and respecting the sovereignty and agency of the affected nations?

# UNITED NATIONS AGENCIES RELATED TO DISASTER MANAGEMENT

Several United Nations (UN) organizations focus on disaster management. Some have direct ties to the main UN body, while others have emerged from the Asian region, prone to earthquakes and cyclones. India actively contributed to their establishment and maintains membership as a full-time participant.

## United Nations Disaster Management Team (UNDMT) In India

The United Nations Disaster Management Team (UNDMT) in India consists of various UN agencies, including FAO (Food and Agriculture Organization), ILO (International Labour Organization), UNDP (United Nations Development Programme), UNESCO (United Nations Educational, Scientific and Cultural Organization), UNFPA (United Nations Population Fund), UNHCR (United Nations High Commission for Refugees), UNICEF (United Nations Children's Fund), WFP (World Food Programme), and WHO (World Health Organization).

### Primary Objectives of UNDMT in India

- To ensure prompt, effective and concerted country-level support to a governmental response in the event of a disaster, at the central, state and sub-state levels,
- To coordinate UN assistance to the government to long-term recovery, disaster mitigation and preparedness,
- To coordinate all disaster-related activities, technical advice and material assistance provided by UN agencies, as well as to take steps for optimal utilisation of resources by UN agencies.

### Collaboration with Nodal Ministries

The UNDMT maintains a close partnership with the nodal ministries of member agencies, providing support following established procedures. This collaborative effort includes significant initiatives such as:

- **Joint Assessments:** In partnership with the Asian Development Bank and World Bank, the UNDMT conducted thorough assessments in the aftermath of the 2004 tsunami and the 2005 Kashmir Earthquake.
- **Program Formulation:** Drawing from the assessments, the UN devised the "Tsunami Recovery Programme" to actively contribute to the recovery and reconstruction efforts in the affected states.
- **Working Group Initiatives:** The UNDMT, in conjunction with the National Disaster Management Authority (NDMA), has collaboratively established a working group. This group is dedicated to initiate pilot projects that address various facets of disaster management.

## UN Office for Disaster Risk Reduction (UNDRR)

- The **UNDRR** provides timely, efficient, and well-coordinated support to governments during disasters.
- UNDRR also facilitates the coordination of UN assistance to the government, focusing on long-term recovery, disaster mitigation, and preparedness initiatives.
- UNDRR oversees and coordinates diverse disaster-related activities, offering technical advice and material assistance from UN agencies.
- **Evolution into UNDRR:** Earlier known as UNISDR, now it known as the United Nations Office for Disaster Risk Reduction (UNDRR). It builds on lessons from the International Decade for Natural Disaster Reduction (1990–1999). The UNDRR incorporates principles from the Yokohama Strategy and the Geneva Mandate on Disaster Reduction.
- **Key Areas of UNDRR's Work:**
  - **Climate Adaptation:** Integrating disaster risk reduction into climate adaptation.
  - **Relief Investments:** Increasing investments in disaster relief.
  - **Resilient Infrastructure:** Building disaster-resilient cities, hospitals, and schools.
  - **Global Readiness:** Enhancing global readiness for future calamities.
- **UNDRR Global Assessment Report:** The UN Global Assessment Report on Disaster Risk Reduction (GAR) is released every two years by UNDRR. It combines inputs from nations, public and private sectors, and disaster-related research. Focuses on understanding systemic risk, measuring risk, and promoting cooperation for better risk governance.
- **Key Findings of GAR 2019:**
  - **Identified Threats:** Points out threats like air pollution, diseases, earthquakes, drought, and climate change.
  - **Investment Impact:** Urges a yearly investment of $6 billion in Disaster Risk Reduction (DRR) for projected benefits of $360 billion.
  - **SDG Progress Warning:** Warns of risks slowing progress on UN Sustainable Development Goals (SDGs).



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- **Vulnerability Disparities:** Countries with limited capacity face higher losses relative to GDP.
- **Call to Action:** Urges governments to shift focus from disaster management to risk reduction through the Sendai Framework.

- **UNDRR and India:** India faced economic losses of $80 billion from 1998 to 2017 due to disasters. In March 2019, India launched a UN-backed initiative involving the Private Sector to reduce disaster exposure and economic losses.
- **UNDRR and ARISE India:** ARISE is a network of private sector entities aligning with the Sendai Framework. ARISE facilitates data exchange, experiences, and projects at local and regional levels.

## United Nations Disaster Assessment and Coordination (UNDAC)

- **Purpose and Establishment:** UNDAC, a team of disaster management professionals funded by member governments, the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), United Nations Development Programme (UNDP), and operational UN Agencies, assist the UN and affected governments in early-phase emergencies.
- **Team Composition and Function:** Comprising multinational disaster/emergency managers, UNDAC rapidly assesses priority needs and coordinates international relief efforts on-site.
- **Deployment of UNDAC Officers:** Trained officers, known as Active members, serve a two-year contract and can be swiftly deployed for rapid assessments and coordination in disaster-affected countries.

## Engagement of Other UN Agencies In Disaster Risk Reduction (DRR)

| Agency | Headquarters | Disaster Reduction Goal |
|---|---|---|
| Food and Agriculture Organization (FAO) | Rome, Italy | Aims to reduce vulnerability to disasters for people before, during, and after such events, as an integral part of its broader disaster management approach. |
| International Labour Organization (ILO) | Geneva, Switzerland | Strives to minimize the impact of disasters on employment and income, promoting measures to reduce risks for livelihoods and supporting efficient post-disaster recovery. |
| International Telecommunication Union (ITU) | Geneva, Switzerland | Works to strengthen emergency communications for the prevention and mitigation of disasters. |
| Office of the United Nations High Commissioner for Human Rights (OHCHR) | Geneva, Switzerland | Emphasizes integrating a human rights-based approach into Disaster Risk Reduction (DRR) and related programs. |
| United Nations Environment Programme (UNEP) | Nairobi, Kenya | Aims to reduce the impact of natural hazards on vulnerable communities through sound environmental management. |
| United Nations Educational, Scientific and Cultural Organization (UNESCO) | Paris, France | Assists member states in building capacities to withstand and cope with natural and human-induced disasters. |
| United Nations Human Settlements Programme (UN-HABITAT) | Nairobi, Kenya | Aims to increase investment in disaster risk reduction, address root causes of disasters, and build a culture of prevention. |
| United Nations Development Programme (UNDP) | New York, USA | Supports disaster-prone countries in developing comprehensive risk reduction programs, strengthening institutional and legislative systems, and promoting community-level preparedness. |

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|---|---|---|
| United Nations Children's Fund (UNICEF) | New York, USA | Develops a global framework for disaster reduction, with a focus on protecting vulnerable groups, especially children and women. |
| World Food Programme (WFP) | Rome, Italy | Aims to strengthen compliance with the Hyogo Framework for Action (HFA) and mainstream Disaster Risk Reduction (DRR) at all levels within the organization. |
| World Health Organization (WHO) | Geneva, Switzerland | Supports countries in building capacity in risk reduction and emergency preparedness. |

## International Search and Rescue Advisory Group (INSARAG)

- **Global Network:** INSARAG, operating under the United Nations, encompasses over 90 countries (till December 2023) and disaster response organizations. Established in 1991 after the 1988 Armenia earthquake, INSARAG focuses on urban search and rescue (USAR) issues, setting standards and methodologies for international USAR teams in earthquake response.
- **Membership:** Countries or organizations with international urban search and rescue response capacity or those prone to earthquakes can join INSARAG. India, a member of INSARAG Asia Pacific Regional Group, actively participates in international and regional meetings. Indian instructors contribute to mock exercises organized by INSARAG.
- **India's Role:** India chaired the INSARAG Asia Pacific Regional Group in 2005-06, organizing meetings and the UNDAC Refresher Course. INSARAG Guidelines provide direction for search and rescue teams in international disaster response operations, covering phases such as preparedness, activation, operation, reassignment/ stand-down, and return to home base.
- **USAR Exercises:** INSARAG conducts regional USAR simulation exercises and awareness training courses annually. These events, hosted by earthquake-prone countries, allow the practice of disaster response coordination methodologies outlined in the INSARAG Guidelines. The INSARAG Asia-Pacific Earthquake Response Exercise in 2011 was held in Agra, India from 4-6 May.

## GLOBAL FACILITY FOR DISASTER RISK REDUCTION (GFDRR)

**About:** GFDRR is a global partnership established in 2006 and hosted by the World Bank Group. Supported by 20 countries and 11 international organizations, it collaborates with over 400 partners at sub-national, national, regional, and international levels.

**GFDRR will focus on four priority areas in the strategy period (2021-2025):**

- **Priority Area One:** Evidence and knowledge on effective disaster and climate resilience approaches are generated and shared for improved policy and practice.
- **Priority Area Two:** Reducing Risk and Mainstreaming Disaster Risk Management.
- **Priority Area Three:** Financial Preparedness to Manage Disaster and Climate Shocks.
- **Priority Area Four:** Disaster Preparedness and Resilient Recovery.

**Financial Goals:** GFDRR aims to leverage at least an additional US$30 billion in resilience investments over the next five years (2021 to 2025). GFDRR plans to support mainstreaming disaster risk management across eight sectors, anticipating leveraging at least US$500 million in each sector, including but not limited to agriculture, education, health, transport, energy, water, and urban development.

**Business Lines:** GFDRR operates through three main business lines to achieve development objectives globally, regionally, and nationally:

| Track | Objective | Target | Focus |
|---|---|---|---|
| I | To strengthen and reorganize ISDR processes | Global and regional partnerships | Increased outreach |
| II | To mainstream Disaster Risk Reduction (DRR) in Development | Low to medium-income countries | Sectoral projects (e.g., health, education, research) |
| III | Standby Recovery Financing Facility (SRFF) for Accelerated Disaster Recovery | Low-income countries | Standby facility for accelerated disaster recovery |



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## ASEAN REGION FORUM (ARF)

- **Establishment and Membership:** The ASEAN Regional Forum (ARF) was established in 1994, with 27 member countries (as of December 2023), including India since 1996. The ARF Unit in Jakarta, Indonesia, has been operating since June 26, 2004.
- **Key Initiatives related to disaster Management**
  - **Disaster Relief Work Plan:** The ARF Disaster Relief Work Plan outlines priorities and activities for regional collaboration in disaster response and relief. These priorities include networking and information sharing, rapid deployment and acceptance of assistance, and interoperability and civil-military coordination in humanitarian operations.
  - **ARF Inter-Sessional Meeting on Disaster Relief (ISM on DR):** It provides a platform for ARF participants to discuss, share best practices, and advance cooperation on disaster management issues.
  - **ARF Disaster Relief Exercises (ARF DiREx):** DiREx exercises focus on improving civil-military coordination, communication, and deployment of resources during disaster response operations.

## SAARC DISASTER MANAGEMENT CENTRE (SDMC)

- **Formation and Membership (1987):** Established on 8 December 1985, the South Asian Association for Regional Cooperation (SAARC) is a collaborative union of South Asian countries, consisting of Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka (till December 2023). SAARC's headquarters are located in Kathmandu set up on 17 January 1987.
- **The inception of SAARC Disaster Management Centre (SDMC) (2006):** In October 2006, the SAARC Disaster Management Centre (SDMC) was established within the premises of the National Institute of Disaster Management in New Delhi. The Director of SDMC is concurrently the Executive Director of the NIDM.
- **Mandate and Responsibilities:** SDMC holds the responsibility of serving all eight SAARC Member Countries by offering policy advice and facilitating capacity-building services. This includes strategic learning, research, training, system development, and the exchange of information. The primary focus is on effective disaster risk reduction (DRR) and management in South Asia.
- **Collaboration and Network Development:** The Centre has proactively developed networks with various organizations and institutions in South Asian countries. This collaboration spans research, documentation, training, and capacity-building initiatives. The aim is to foster better cooperation and understanding among countries for a comprehensive approach to disaster management.
- **Core Functions of SAARC Disaster Management Centre:** The SAARC Disaster Management Centre (SDMC) serves as a hub for disaster-related functions in SAARC countries. It focuses on documentation, analysis, and dissemination of disaster-related data and information, conducts educational initiatives, develops training modules, provides policy assistance, organizes workshops and conferences, and collaborates with other SAARC centres for enhanced program synergies.

**IGNITE YOUR MIND**

Picture a scenario where cultural diplomacy is integrated into disaster response efforts between India and its neighbouring nations. Do you think the exchange of cultural insights and practices enhances the effectiveness of collaborative disaster management?

## CRITICAL ANALYSIS OF INTERNATIONAL COOPERATION AND RESPONSE TO DISASTER

### Challenges in International Disaster Response and Cooperation

- **Diverse Priorities and Capabilities:** Developed nations prioritize technological solutions, while developing nations focus on immediate relief, which leads to mismatched support and inefficient resource allocation.
- **Political and Logistical Hurdles:** Complexities like bureaucratic procedures, visa restrictions, and communication infrastructure delays delay international assistance deployment.
- **Cultural Differences and Communication Gaps:** Misunderstandings and communication barriers impede collaboration between international responders and local communities.
- **Unsustainable Dependency:** Excessive reliance on international aid discourages local capacity building, hindering long-term resilience.
- **Accountability and Transparency:** Challenges in responsible resource use post-disaster chaos.

### Advantages of International Cooperation

- **Leveraging Expertise and Resources:** International collaboration provides access to skills, technology, and resources, improving disaster response and recovery.
- **Facilitating Knowledge Exchange:** Cross-border sharing of knowledge enhances preparedness, prevention strategies, and disaster management.



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- **Fostering Global Solidarity:** International cooperation attracts financial support for reconstruction and development efforts.
- **Enhanced Coordination and Communication:** Collaborative platforms and communication networks streamline information sharing and coordination.
- **Building Resilience and Reducing Risk:** International cooperation supports long-term risk reduction strategies, infrastructure development, and community-based resilience initiatives.

## Way Forward

- **Strengthening Global Coordination Mechanisms:** Establishing robust platforms like the **UN Office for Disaster Risk Reduction (UNDRR)** and the G20 Working Group on **Disaster Risk Reduction (DRR)** facilitates collaboration and joint action.
- **Investing in Local Capacity Building:** Prioritizing local expertise, infrastructure, and resource building in international aid ensures long-term sustainability and reduces dependence on external assistance.
- **Encouraging Regional Collaboration:** Fostering cooperation within geographically proximate regions with similar vulnerabilities allows for faster response, joint training exercises, and tailored solutions.
- **Promoting Cultural Sensitivity and Communication:** Training responders in cultural awareness and effective communication is crucial for building trust and ensuring successful collaboration with affected communities.
- **Prioritizing Transparency and Accountability:** Implementing robust monitoring and evaluation mechanisms ensures responsible resource use and builds trust among international partners.

## CONCLUSION

In the face of escalating natural hazards and the intricate web of interconnected risks, international cooperation in disaster management is no longer a luxury, but a necessity. This promotes shared knowledge, swift response, and unwavering solidarity, where borders fade and humanity stands united against the forces of nature. This chapter has explored the multifaceted dimensions of this global endeavor, delving into the exchange of best practices, the deployment of rapid response teams, and the crucial role of technology in bridging geographical divides.

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# Climate Change and Disaster

# 9

## INTRODUCTION

Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850-1900 in 2011-2020. Global greenhouse gas emissions have continued to increase, with unequal historical and ongoing contributions arising from unsustainable energy use, land use change, lifestyle change and consumption as well as production patterns across regions, among individuals and inter and intra national. Climate-related disaster risk is defined as the expected value of losses, often represented as the likelihood of occurrence of hazardous events multiplied by the impacts (effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure), if these events occur. Climate change can increase disaster risk in a variety of ways - by altering the frequency and intensity of hazard events, affecting vulnerability to hazards, and changing exposure patterns.

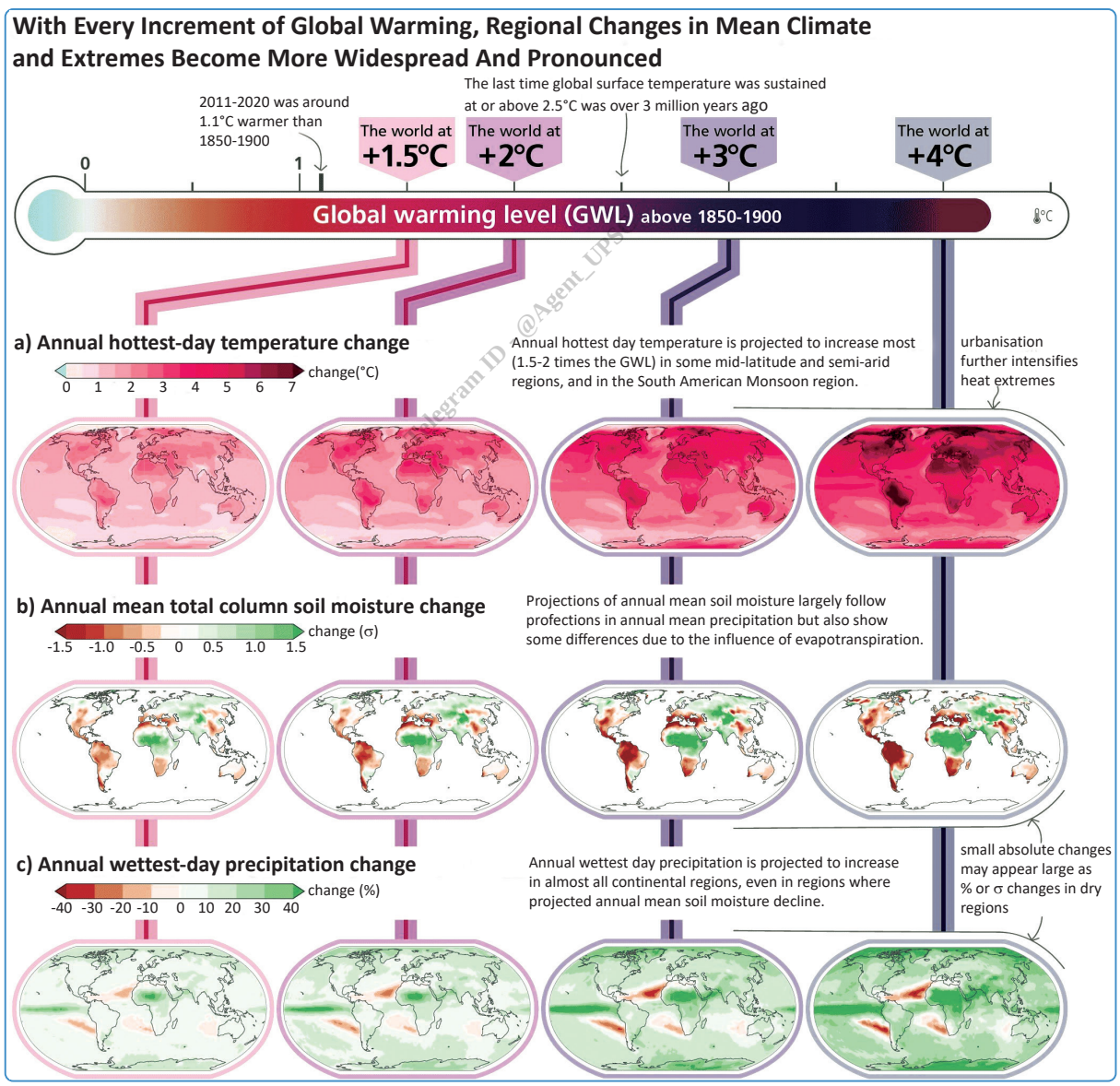


**Fig 9.1:** Impact of Rising Temperature of Globe

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## LINKAGE BETWEEN CLIMATE CHANGE AND DISASTERS

According to the **Intergovernmental Panel on Climate Change,** an increase of greenhouse gases in the atmosphere will probably boost temperatures over most land surfaces, though the exact change will vary regionally. More uncertain—but possible—outcomes of an increase in global temperatures include **increased risk of drought and increased intensity of storms, including tropical cyclones with higher wind speeds, a wetter Asian monsoon, and, possibly, more intense mid-latitude storms.**

Climate-related disasters have almost doubled compared to the previous twenty years. This has exacerbated inequalities within and among different nations, with those contributing least to global emissions often experiencing the worst impacts of the climate emergency.

### Climate Change As A Disaster Risk Driver

- **Cyclones:** Warmer ocean temperatures are providing more energy for tropical storms, hurricanes, and typhoons. These storms are becoming more intense and unpredictable, causing greater damage when they make landfall.
- **Drought:** Climate change is altering weather patterns, leading to more frequent and severe droughts. These droughts can devastate agriculture, leading to food shortages and economic hardship. The number of people suffering extreme droughts across the world could double in less than 80 years
- **Floods:** More intense rainfall events and melting glaciers are contributing to an increase in floods. These can cause widespread damage to infrastructure, homes, and livelihoods.
- **Heatwave:** Heat stress from extreme heat and humidity could annually affect 1.2 billion people by 2100.
- **Creating New Disaster Risks:** Climate change is also contributing to new types of disasters, such as landslides triggered by melting permafrost and coastal erosion due to rising sea levels. These emerging risks pose additional challenges for disaster preparedness and response.
- **Infectious diseases:** Climate change is creating conditions that are favourable for the spread of infectious diseases. For example, warmer temperatures can allow mosquitoes to breed and spread diseases like malaria and dengue fever. Changes in rainfall patterns can also lead to outbreaks of waterborne diseases.
- **Sea level rise:** Coastal flooding events could threaten assets worth up to 20% of the global GDP by 2100.
- **Wildfire:** By 2030, fire season could be three months longer in areas already exposed to wildfires.
- **Glacial Lake Outburst Floods:** Climate change is causing glaciers to melt at an alarming rate, leading to the formation of new glacial lakes. These lakes are often unstable and can burst their banks, sending a torrent of water and debris down into valleys below.
- **Lightning:** Warmer air holds more moisture, creating supercharged storm clouds that unleash more frequent and intense lightning strikes. Rising temperatures also alter wind patterns, leading to more erratic storm tracks and increasing the chances of lightning strikes in unexpected areas. This potent combination is expected to make lightning a more common and dangerous threat in the years to come.

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## IPCC SIXTH ASSESSMENT REPORT: CLIMATE CHANGE AND DISASTER MANAGEMENT

In the near term, every region in the world is projected to **face further increases in climate hazards, increasing multiple risks to ecosystems and humans.** Hazards and associated risks expected in the near term include an increase in **heat-related human mortality and morbidity , food-borne, water-borne, and vector-borne diseases,** and mental health challenges, flooding in coastal and other low-lying cities and regions, biodiversity loss in land, freshwater and ocean ecosystems, and a decrease in food production in some regions. **Cryosphere-related changes in floods, landslides, and water availability** have the potential to lead to severe consequences for people, infrastructure and the economy in most mountain regions. The projected increase in frequency and intensity of heavy precipitation will increase rain-generated local flooding.



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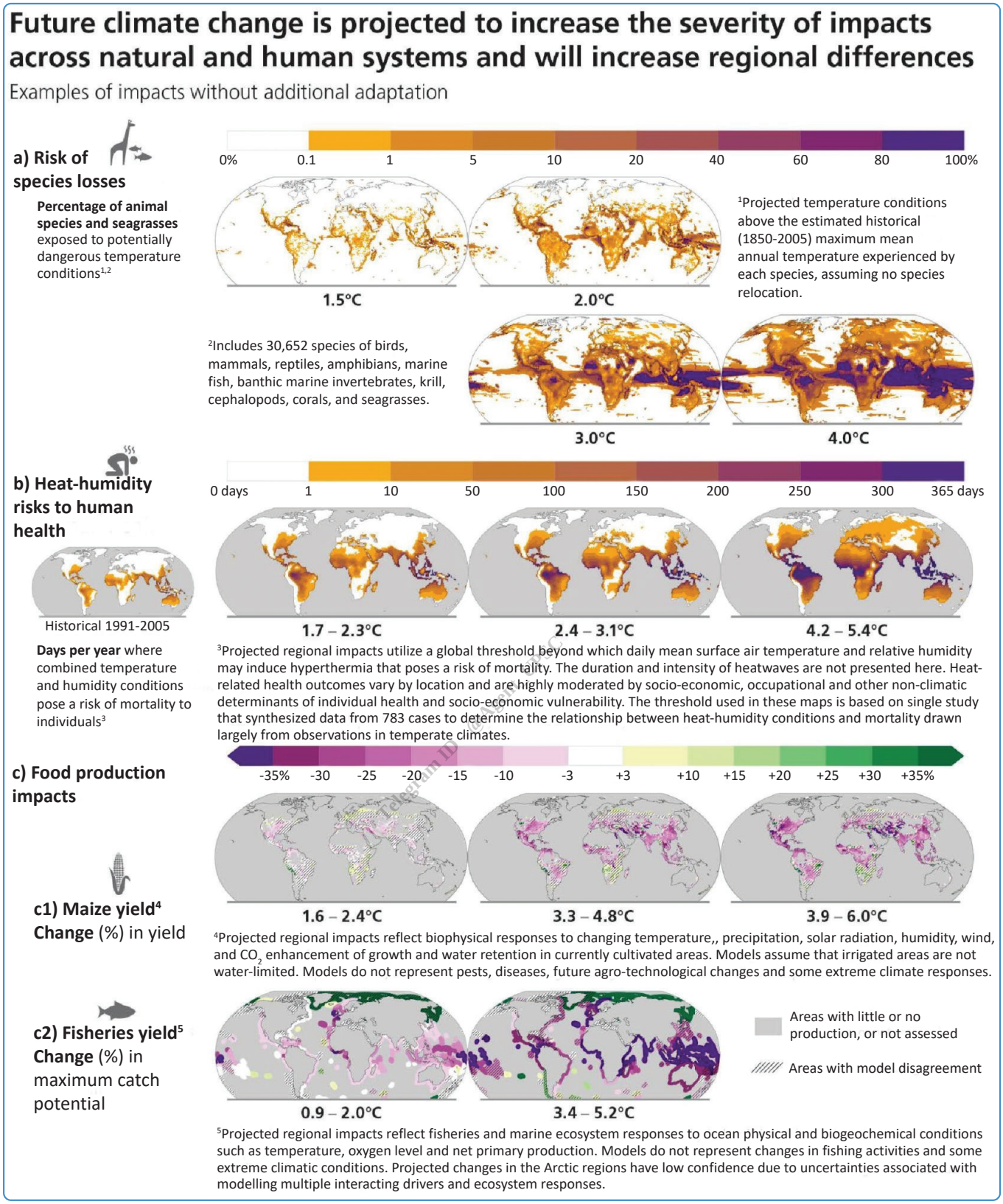


**Fig. 9.2:** Predicted Impact of Climate change on Various Aspects

## Challenges To Managing Climate-Induced Disasters

- **Limited Predictability:** Climate-induced disasters often have unpredictable patterns, making it difficult to provide accurate early warnings and plan evacuation strategies. **Example:** The monsoon in India in **2023 arrived in Mumbai and Delhi** at the same time, which hadn't happened in more than 50 years.



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- **Increased threat to Vulnerable Populations:** Vulnerable communities, including low-income populations and marginalised groups, are disproportionately affected by climate-induced disasters due to inadequate infrastructure, limited access to resources, and social inequalities. Approximately **250 million people in India are vulnerable to climate change impacts,** with the poorest populations (Like Coastal and hilly area communities, small farmers etc) facing the highest risk.
- **Increased Frequency and Intensity:** Climate change is causing more frequent and intense disasters, making it challenging to predict, prepare and respond to these events effectively.
- **Urbanisation and Infrastructure Development:** Rapid urbanisation and poorly planned infrastructure in vulnerable areas increase the exposure and vulnerability of population to climate-induced disasters. The urban population in India is projected to reach 814 million by 2050, exacerbating vulnerabilities to climate-induced disasters. **Example: Cyclone Yaas in 2021** hit Odisha, flooding low-lying areas due to poorly maintained drainage systems, and exposing the risk of unplanned development in disaster-prone zones.
- **Lack of Comprehensive Risk Assessment:** Inadequate understanding of the comprehensive risks, including secondary and cascading effects, can result in insufficient preparation and response strategies. **Example:** The 2013 Uttarakhand floods in India revealed the lack of comprehensive risk assessment, leading to inadequate preparation for extreme rainfall events (Ministry of Home Affairs).
- **Policy Gaps and Implementation Deficits:** Gaps in policies, along with challenges in implementing and enforcing existing regulations, can undermine effective disaster risk reduction and climate adaptation measures. **Example:** In India, a 2021 study published in the journal 'Atmospheric Chemistry and Physics' reflected that by the end of the century, lightning frequency is set to rise by between 10% and 25%, while its intensity is expected to increase by between 15% and 50%. But **lightning is not considered as a disaster by the Indian Government.**

### Monsoon Mayhem 2023

- **Overview**
  - In August, the southern peninsula received 104% more rainfall than normal while in central India, the rainfall was 78% more than normal.
  - The Karnataka state received an average rainfall of 224 mm against the normal downpour of 59 mm.
  - In Kerala's Wayanad district, the departure from normal rainfall was 400% between August 8 and 14 while Malappuram received 500% more rain than usual in the same period.
- **Is it a first extreme event?**
  - Analysis conducted by the Council on Energy, Environment, and Water (CEEW) indicate that India has witnessed over 478 extreme events since 1970, with a notable acceleration in their frequency after 2005.
  - The period from 1970 to 2005 recorded an average of 250 extreme events, while the post-2005 period witnessed a surge to 310 extreme events and associated occurrences.
- **Climate Change as Culprit:**
  - Land temperature rises, as it has been due to global warming, the atmosphere heats up too. This in turn increases the atmosphere's capacity to hold moisture and also its rate of absorption of moisture. When this happens in a conducive environment, like one where a low-pressure area has been formed, it creates a situation favourable for a high rate of rainfall in certain pockets.
  - Also, Global Warming causes **increased evaporation** resulting from rising global surface and ocean temperatures.
- **Future Risk:**
  - The Ministry of Earth Sciences report, **'Assessment of Climate Change over the Indian Region,'** highlights that future monsoonal rainfall is projected to become more intense and affect larger areas due to increased atmospheric moisture content resulting from temperature rise.
- **Previous Warning:**
  - The Intergovernmental Panel on Climate Change (IPCC) report, **'Weather and Climate Extreme Events in a Changing Climate,'** had already warned of increased summer and monsoon precipitation, along with a 20 percent surge in extreme rainfall events on the Indian subcontinent.

## How To Manage Climate-Induced Disasters

- **Early Warning Systems:**
  - With timely warnings, people can take early action by blocking up doors with sandbags to anticipate floods, stockpiling resources, or in some extreme cases, evacuating from their homes.
  - **Example:** In Bangladesh, even as climate change becomes more severe, the number of deaths from cyclones has fallen by 100-fold over the past 40 years, due mainly to improved early warnings.

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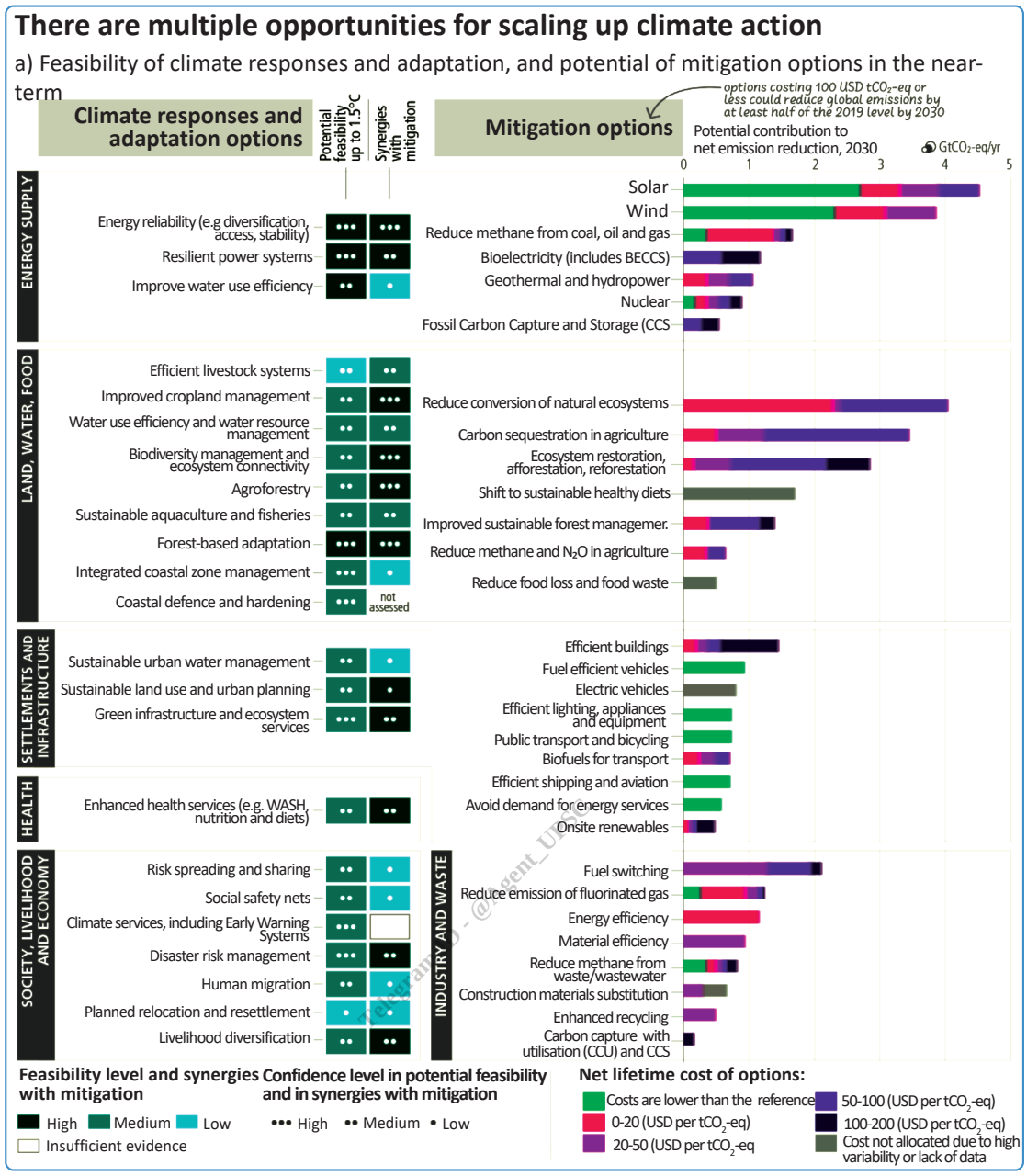


**Fig 9.3:** Opportunities for Scaling up the Climate Action

- **Ecosystem Restoration:** Nature-based solutions, like urban forest restoration and mangrove protection, offer climate resilience. In cities, restoring urban forests cools the air and reduces heat waves.
  - In high altitudes, re-greening mountain slopes protects communities from climate-induced landslides and avalanches. The **Miyawaki afforestation** method is one of the best examples of Ecosystem Restoration.
- **Climate-resilient infrastructure:**
  - Climate-resilient infrastructure refers to assets like roads and bridges that withstand extreme climate impacts.
  - Tools for encouraging investments in climate-resilient infrastructure include regulatory standards like building codes, spatial planning frameworks such as vulnerability maps, and a strong communication drive to ensure the private sector is aware of climate risks, projections and uncertainties.
  - **Example:** Concepts like **'Sponge cities'** (They are urban areas with abundant natural areas such as trees, lakes and parks) which are embraced by cities like Shanghai, New York and Cardiff.
- **Water Supplies and Security:**
  - Adaptation of water and sanitation infrastructure is vital for the resilience of societies and natural environments to increasing numbers of disasters.
  - Investing in efficient irrigation and urban water management is crucial.
  - The **Sendai Framework for Disaster Risk Reduction emphasises water management as essential** for reducing the occurrence and impacts of water-related disasters.



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- **Long-Term Planning:**
  - National Adaptation Plans are crucial for strategic adaptation prioritisation. Examining climate scenarios and vulnerability assessments aids long-term planning.
  - **Example:** Launching of national action plan on climate change by India which focuses on building national S&T capacities in the area of climate change.

## International Efforts To Mitigate Climate Change

- **UNFCCC:**
  - The United Nations Framework Convention on Climate Change, adopted in 1992, is the overarching legal framework for international cooperation on climate change.
  - It serves as the foundation for subsequent agreements like the Paris Agreement.
  - COP28 Declaration on Climate Change and Health which enshrines a collective commitment to increase investment and actions to drive resilience in countries and communities affected by conflict, fragility or humanitarian crisis.
- **Kyoto Protocol:**
  - Adopted in 1997, it was the first legally binding agreement requiring developed countries to reduce greenhouse gas emissions by specific targets.
  - While superseded by the Paris Agreement, it remains relevant for its focus on emissions reduction strategies for developed countries.
- **Paris Agreement:**
  - Adopted in 2015, it is the primary global framework for climate action.
  - Its main goal is to hold global temperature rise below 2°C (ideally 1.5°C) compared to pre-industrial levels, thus mitigating future extreme weather events.
  - Each signatory sets Nationally Determined Contributions (NDCs) outlining their emission reduction targets and mitigation strategies.

### India's Nationally Determined Contributions (NDCs)

The Paris Agreement requires each Party to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions. In August 2022, India updated its NDCs.

- To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation, including through a mass movement for **'LIFE'– 'Lifestyle for Environment'** as a key to combating climate change [ UPDATED]
- To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
- To **reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level** [UPDATED].
- To **achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030,** with the help of transfer of technology and low-cost international finance including from Green Climate Fund (GCF) [UPDATED].
- To create an additional carbon sink of 2.5 to 3 billion tonnes of $CO_2$ equivalent through additional forest and tree cover by 2030.
- To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.
- To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
- To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate tecthnology in India and for joint collaborative R&D for such future technologies.

This update to India's existing NDC is a step forward towards our long term goal of reaching net-zero by 2070.

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## Best Practices Adopted Worldwide To Counter Such Events

- **Imposing Carbon Taxes**
  - **Purpose:** Minimize greenhouse gas emissions by making major producers pay for environmental damage.
  - **Example:** Sweden, an early adopter in 1991, achieved a 27% reduction in emissions.
- **Cap and Trade Mechanism**
  - **Purpose:** Government program capping private-sector emissions, trading permits for the right to emit.
  - **Example:** California's 2013 program led to a 10% reduction in emissions by 2018.
- **Clean Energy Standards**
  - **Purpose:** Encourage low-emission energy sources, like solar or wind power, to reduce electricity-related emissions.
  - **Example:** To decrease emissions, around two-thirds of U.S. states have implemented clean energy standards—laws that encourage utility companies to generate a certain percentage of their electricity from low-emission energy sources, such as solar or wind power.



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- **Adaptation Policies**
  - **Purpose:** Governments address worsening extreme weather events by implementing policies to increase resilience.
  - **Example:** The U.S.'s Low-Income Home Energy Assistance Programme aids vulnerable communities during climate-related events.

## THE HIMALAYAN PLUNDER- A CASE STUDY

The last few decades have recorded rapid and magnified natural catastrophes across the world, with scientists linking such extreme events with global warming. The **Himalayas have recorded such calamities like earthquakes, avalanches, cloud-bursts, intense rainfall landslide lake outburst floods** (LLOFs are breaching of lakes formed by obstructions due to landslides), and **glacial lake outburst floods** in their most furious forms; ground studies indicate a warming climate as the cause.

### The Plunder Manifests in Various Forms

**Fig.9.4:** Sun Shadow Slope

- **Construction in Most Fragile regions:** The warming climate has the maximum impact in the areas intermediate between glaciated and non-glaciated terrain—these are the areas that receive snowfall as well as rainfall. **It is pertinent to mention that most of the disastrous catastrophes, including the Kedarnath floods of 2013, the Chamoli flash floods of 2021 and the subsidence in Joshimath, have occurred in such intermediary climatic zones.**
  - **Why construction in intermediary Zones?:** Such intermediary climatic zones, with picturesque glacial landscape and easy access offers a natural choice for tourism and subsequent developments. With the sudden change in topographic altitudes and availability of perennial sources of water, such places also offer the best suitable sites for the development of river valley projects.
  - **Hazard Prone:** While the entire Himalayan region is fragile due to its immature topography under continued active erosional and weathering processes, the **intermediary zones may be regarded as the most fragile and unstable belt on account of the interplay of glacial and fluvial (dominated by rivers and streams) processes.**
  - **Sun Shadow regions:** Most human settlements are located on **north-to-easterly** directed valley slopes, which see less solar insolation(sun-shadow slopes). Thus, these areas have seen prolonged glacial activity that resulted in gentler, deeply weathered slope covered with thick fluvioglacial debris. The debris comprises large boulders set in a mixture of clay and pebble-sized rock fragments. **Landslides and some amount of creep (slow, downslope movement of soil and earth materials) are common on such slopes primarily due to the permanent wetness of the ground, however, the areas turn to a "sinking zone" or debris slide due to excessive ground saturation clubbed with unscientific surficial loading, slope modification and toe removal or erosion.** Several areas of Himachal Pradesh, like Kothi near Manali, Prashar Lake Rari village near Bajaura in Beas valley and Reckong Peo, Urni in Kinnaur district are on such slopes.
- **Deforestation:** Greedy loggers strip away the green cloak of the mountains, leading to soil erosion, flash floods, and habitat loss.
  - **Example:** Rampant deforestation in Himachal Pradesh, for tourism and road projects weakens slopes, triggering landslides like the July 2023 Shimla tragedy.
- **Tourism Onslaught:** According to reports, tourism has increased by between 50 and 60 percent since the 1990s. This has caused extensive deforestation and unsustainable construction in the mountain areas which trigger disasters. Tourism also adds to **waste generation in the absence of adequate treatment and disposal systems, plying of more vehicles and construction.**
- **Unsustainable Water Management:** Over Extraction of groundwater and lack of rainwater harvesting systems in Ladakh's cold deserts threaten water security and agricultural productivity.

### The Consequences of Himalayan Plunder

- **Livelihoods Lost:** Disruptions to natural resources and ecosystems threaten the livelihoods of millions who depend on the Himalayas for agriculture, forestry, and tourism.
- **Land Sinking:** Sitting atop ancient glacial debris, the region had been this is correct in context of the event following it. In January 2023, Joshimath was hit by a geological phenomenon known as land subsidence, which is a gradual settling, or sinking of the surface due to the removal of water, oil, natural gas, or mineral resources from the ground.



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- **Water Woes:** Shrinking glaciers and disrupted water flows spell water scarcity for millions downstream, jeopardising agriculture and drinking water supplies.
- **Disaster Dominoes:** Increased vulnerability to natural disasters like floods, landslides, and earthquakes puts millions of lives at risk.
- **Biodiversity in Peril:** The unique plants and animals of the Himalayas, many already endangered, face habitat loss and fragmentation, pushing them towards extinction.

## WAY FORWARD

- **Prioritise Sustainable Development:** Upslope areas should be investigated for landslide and avalanche or debris flow, to avoid deadly incidents like the landslides in Boi and Batseri, Himachal Pradesh, which occurred last year. Downslope or valley establishments must, at the same time, be checked for risk of high-level floods due to cloud bursts, Glacial Lake Outburst Floods (GLOFs) or Landslide Lake Outburst Floods (LLOFs).
- **Policy caution:** A policy mandating geological inputs during pre-construction, construction stage and post-construction monitoring of proposed or existing settlements and projects is also needed.
- **Responsible Tourism:** Himalayan states must introduce legislations for enforcing building codes, a ban on major activities and projects in fragile zones and geologically sustainable surface connectivity projects. Immediate measures include planning and practising for rapid response, evacuation, monitoring and early warning systems and technologies, with participation from people.
- **Following Good Practices:** Engineers and contractors do acquire some practical knowledge, but we must find a way to ensure that this is scientifically tested, documented and converted into manuals for both safety and proper construction processes.
- **Empower Communities:** The **Van panchayats** should be expanded by implementing the Community Forest Rights provision of the Forest Rights Act. The local governments must be given powers sanctioned by the 73rd and 74th Constitutional Amendments to decide on the use of all natural resources, including streams and rivers.
- **Understanding the Vulnerability:** Local geography needs to be considered for every aspect of development. The solution is to understand the science of nature, not just use science for development.

## CONCLUSION

The compounding effects of climate change pose unprecedented challenges to human and natural ecosystems, impacting economic activities and posing severe threats to livelihoods. While efforts to combat climate change have escalated at regional, national, and subnational levels, the rapid compounding of climate change impacts necessitates urgent and comprehensive action. Without a concerted global response, India and other nations will continue to bear the brunt of extreme weather events, risking lives, infrastructure, and socio-economic stability.

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# Covid-19 and Disaster Management

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*"We are facing a global health crisis unlike any in the 75-year history of the United Nations. One that is killing people, spreading human suffering, and upending people's lives".*

*-Antonio Guterres*

## INTRODUCTION

Cases of novel coronavirus (nCoV) were first detected in China in December 2019, with the virus spreading rapidly to other countries across the world. This led WHO to declare a Public Health Emergency of International Concern (PHEIC) on 30 January 2020 and to characterize the outbreak as a pandemic on 11 March 2020. While news reports primarily focused on rising case numbers and overwhelmed hospitals, what unfolded in India was a story far more complex. It wasn't just a health crisis, but a social, economic, and even existential disaster playing out across the fabric of a diverse nation. This chapter delves into the unique challenges and triumphs of India's response to this unprecedented event, examining the effectiveness of disaster management strategies in the face of an invisible enemy.

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### Data-Wise

- **Death and Vaccine in the World:** According to WHO, as of December 2023, there have been 77,23,86,069 confirmed cases of COVID-19, including 69,87,222 deaths. As of November 2023, a total of 13,59,57,21,080 vaccine doses have been administered worldwide.
- **Death & Vaccine in India:** According to the Home Ministry in India, till **3 February 2024, the Total Vaccination of people had been 2,20,67,87,087**. While total cases were 4,50,25,951 death numbers are near 5,33,454.
- **GDP Contraction:** India's GDP plummeted by a staggering 7.3% in FY 2020-21, translating to a real GDP loss of Rs. 9.22 lakh crore **(Ministry of Statistics and Programme Implementation, 2023)**.
- **Job Losses and Unemployment:** Millions bore the brunt of job losses, with sectors like tourism (76%), hospitality (41%), and retail (21%) experiencing significant downturns (Centre for Monitoring Indian Economy, 2020). The unemployment rate skyrocketed to 23.5% in May 2020, pushing an estimated 122 million people out of work **(World Bank, 2023)**.
- **Supply Chain Disruptions:** Global lockdowns snarled supply chains, with import delays of up to 40% and export contractions exceeding 30% **(Federation of Indian Export Organizations, 2020)**.
- **Inflation:** This choked raw material availability and triggered a 7.3% spike in inflation, further squeezing household budgets **(Reserve Bank of India, 2020)**.

## COVID-19 AS A DISASTER

- **Meaning of Disaster:** Section 2 (d) of the DM Act states that a disaster means a "catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes."
- **Invoking the NDMA Provisions:** In March 2020 the government of India imposed a 21-day national lockdown. This marks the first time since the law came into being that the **NDMA provisions have been invoked.** Sections 6 and 10, under which the lockdown order was issued, give the NDMA powers to **prepare national plans for disaster management and ensure its implementation through the state disaster management authorities in a uniform manner.**
- **Role of National Executive Committee:** Section 10 of The Disaster Management Act deals with the powers and functions of this national executive committee. This section also empowers the National Executive Committee to lay down guidelines for or give directions to, the concerned Ministries or Departments of the Government of India, the State Governments and the State Authorities regarding measures to be taken by them in response to any threatening disaster situation or disaster. **It is under this section that the Union Home Ministry has been issuing guidelines for the containment of Covid-19.**

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## CHALLENGES FACED BY INDIA

- **Healthcare:** The worst-affected nations, Italy, the United States, and China have 3.2, 2.8, and 4.3 **hospital beds per 1000 inhabitants**, respectively. In comparison, India had just about 0.55 beds per 1,000 inhabitants. Furthermore, the overall ICU capacity is less than a million. India has a **doctor-patient ratio** of 1:1445 compared to the WHO standard of 1:1000. A similar predicament happens for other health workers such as paramedics and nurses.
- **Population density:** India is the second most populous country in the world, with high population densities in some areas, especially in major cities such as Mumbai and Delhi.
- **Poverty and illiteracy:** Poverty is a huge issue in India as, after Nigeria, India has the poorest people in the world. India's literacy rate is 74.04%, with rates changing by state. The great majority of the population is illiterate, semi-literate, or uneducated. They are completely unaware of a COVID-19-like outbreak and the necessary preventative actions.

## IMPACT OF COVID-19

### Social Impact

- **Women:** Women shouldered the burden of increased household chores and childcare due to school closures and lockdowns, adding to their pre-existing workload. Lockdowns and economic stress led to a rise in reported cases of domestic violence and exploitation.
- **Children:** Lockdowns disrupted education, mental health, and nutrition, affecting disadvantaged children, and causing increased anxiety, stress, and social isolation. Economic hardships exacerbated family tensions and exploitation risks.
- **Migrant Workers:** A survey by Azim Premji University estimated that 82% of migrant workers lost their jobs during the pandemic. A 2021 report by the International Labour Organization (ILO) revealed that India witnessed the highest internal labour migration movements across the world due to the pandemic.
- **Older adults:** COVID-19 has led to higher mortality rates in older adults, increased social isolation, limited healthcare access, and economic vulnerabilities, particularly for those reliant on pensions or informal work, highlighting the need for improved mental and emotional well-being.
- **People with disabilities:** The pandemic has exacerbated accessibility challenges for people with disabilities, leading to increased reliance on caregivers, mental health issues, and economic vulnerabilities, as lockdowns and social distancing measures overlook their needs.

### Economic Impact

- **Daily Wage Earners**
  - **Precarious livelihoods:** Informal, day-to-day work across sectors like street vending and housekeeping came to a standstill, leaving many without income and food security.
  - **Limited access to government assistance:** Informality often excludes them from social safety nets, making them particularly vulnerable during crises.
- **Economic slowdown and recession:** The pandemic triggered a severe economic slowdown, with GDP growth plunging and unemployment rising significantly. Businesses across various sectors suffered massive losses.
- **Disruption of supply chains and trade:** Lockdowns and travel restrictions disrupted global supply chains, impacting trade and further weakening the economy.
- **Stress on public finances:** Increased healthcare expenditure and economic relief measures put pressure on government finances, limiting resources for other crucial sectors.

### Environmental Impact

- **Reduced air and water pollution:** Strict lockdowns led to temporary improvements in air and water quality due to reduced industrial activity and vehicular emissions.
- **Increased waste generation:** Increased reliance on single-use masks and medical disposables led to a surge in waste generation, posing environmental challenges.
- **Disruption of waste management systems:** Lockdowns and resource constraints disrupted waste management systems, leading to potential environmental pollution.
- **Impact on wildlife and biodiversity:** Movement restrictions affected wildlife corridors and potentially impacted biodiversity, though long-term studies are needed for clear assessment.
- **Focus on sustainable solutions:** The pandemic sparked interest in adopting sustainable practices like waste reduction and renewable energy, offering potential long-term environmental benefits.

## INDIA'S RESPONSE

### Successes

- **Early Activation and Swift Action**
  - **NDMA and SDMAs:** The swift activation of the National Disaster Management Authority (NDMA) and State Disaster Management Authorities (SDMAs) ensured a coordinated response across government agencies, healthcare units, and local bodies.
  - **Travel restrictions:** Early travel restrictions, including international flight suspensions and visa limitations, helped delay the virus's entry and spread.

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- **Risk assessment and preparedness:** NDMA's early risk assessment and activation of emergency response plans laid the groundwork for subsequent actions.

❑ **Nationwide Lockdown**

- **Flattening the curve:** While controversial, the initial nationwide lockdown provided crucial time to:
  - Increase hospital bed capacity and critical care infrastructure.
  - Train medical personnel and establish contact tracing mechanisms.
  - Increase awareness and implement containment measures.
- **Graded Unlock Policy:** The phased unlocking of lockdown restrictions based on risk assessment and data-driven decision-making ensured a gradual easing of restrictions while safeguarding public health.

❑ **Leveraging Existing Networks**

- **ASHA workers:** Leveraging the vast network of ASHA workers for awareness campaigns, health checks, and essential service delivery in rural areas proved invaluable.
- **Anganwadi workers:** Similarly, Anganwadi workers played a crucial role in disseminating information, addressing specific needs like childcare, and supporting vulnerable families.

❑ **Digital Innovations**

- **Aarogya Setu App:** The Aarogya Setu App facilitated contact tracing, self-assessment, and access to essential resources, promoting proactive individual engagement.
- **Co-WIN Vaccinator App:** A Vaccine registration and information platform for Online platforms streamlined vaccine registration, appointment booking, and information dissemination, enhancing accessibility and efficiency.

❑ **Targeted Policy Interventions**

- **PMGKAY:** Initiatives like Pradhan Mantri Garib Kalyan Yojana (PMGKY) provided financial aid and essential supplies to vulnerable populations, mitigating economic hardship during lockdowns.
- **Other targeted policies:** Tailored schemes for specific sectors like agriculture, micro, small and medium enterprises (MSMEs), and tourism helped cushion the economic blow for vulnerable groups.

**IGNITE YOUR MIND**

India's strict lockdown, while effective in flattening the curve, had a devastating impact on the informal economy and daily wage earners. Can you think of a few future disaster management strategies to achieve a better balance between protecting lives and livelihoods?

## Areas for Improvement

❑ **Inconsistent Implementation**

- **Urban-rural disparities:** The lockdown exposed gaps in accessibility of essential services and enforcement between urban and rural areas, particularly in slums and remote locations.
- **Vulnerable groups:** Implementation challenges affected marginalized communities like migrant workers, daily wage earners, and minority groups disproportionately.

❑ **Supply Chain Disruptions**

- **PPE and medical supplies:** Dependence on global supply chains led to shortages of personal protective equipment (PPE) and medical supplies, highlighting the need for domestic production capabilities.
- **Essential goods distribution:** Logistical bottlenecks and disruptions in essential goods distribution networks during lockdowns posed challenges for accessing basic necessities.

❑ **Healthcare Infrastructure Gaps**

- **Rural healthcare access:** The pandemic exposed limitations in rural healthcare infrastructure, including insufficient hospital beds, medical personnel, and critical care facilities.
- **Uneven distribution of resources**: Urban-rural and inter-state disparities in healthcare resources highlighted the need for equitable distribution and investment in rural health systems.

❑ **Misinformation and Stigma**

- **Widespread misinformation:** The pandemic saw a surge in misinformation, hindering awareness campaigns and vaccine uptake. Countering misinformation with accurate and accessible information remains crucial.
- **Stigma against infected individuals:** Social stigma associated with COVID-19 hampered contact tracing efforts and caused undue emotional distress for affected individuals. Promoting empathy and addressing stigma through public awareness campaigns and community engagement are essential.

❑ **Focus on Long-Term Resilience**

- **Disaster preparedness:** Investing in long-term disaster preparedness plans and infrastructure upgrades for future epidemics and other potential threats is vital.
- **Social safety nets:** Strengthening social safety nets and livelihood diversification policies can better equip vulnerable communities to withstand future shocks.
- **Community engagement:** Building resilience requires active community engagement in preparedness measures, risk reduction strategies, and information dissemination.

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## State-Level Measures

### Delhi

**Challenges:** Delhi's dense population and high density make it challenging to contain COVID-19 spread. The migrant population, many of whom work in informal sectors, is also vulnerable. The city's international travel and connecting flights make it a potential entry point. The Nizamuddin Markaz outbreak in 2020 highlighted the challenges of controlling COVID-19 in religious gatherings. The spread of fake news has also contributed to social unrest and division.

### Steps Taken by Administration

- Delhi's 5T Plan for COVID-19 Response
  - **Testing:** Delhi conducted 696 tests/million till April 13, 2020.
  - **Tracing:** Planned to trace individuals who come into contact with a positive patient.
  - **Treatment:** Planned for 8000 hospital beds to handle up to 30,000 active cases.
  - **Teamwork:** The state collaborated with technology professionals, doctors, and nurses.
  - **Tracking and Monitoring**: Actively monitored the implementation of the 5T programme.
  - **Technology**: The Delhi Government released the "**Assess Koro Na**" application to perform door-to-door surveys in COVID-19 containment zones. The acquired data is promptly transferred to the servers and analysed. The control centres will access this data and make timely choices to meet demands such as ambulance services, medical experts, and so on.
- **Relief Work:** Free food for ration card holders and 2000 food coupons distributed to the poor.
- **Support for impacted transport service providers:** Rs 5,000/- each to their bank accounts.
- **Operation SHIELD:** The Delhi Government declared it to control the virus's spread in the city's 21 containment zones or hotspots.
- **Leadership:** CM and state administration ensured the efficient execution of the plan.
- **Closures and Restrictions**: Schools, colleges, cinema halls, offices, and shopping malls closed.

## Kerala

### Challenges

- **First COVID-19 patient:** In India was a medical student from Wuhan, China. The state authorities were left with little time to prepare for the rising cases.
- **Inflow from outside:** Tourism inflows, both domestic and international, are a potential infection source.
- **Inadequate test kits:** Especially needed earlier than in other states, posed a challenge.

### Steps Taken by Administration

- **Financial Package:** The Kerala government announced a Rs. 20,000 crore financial package to manage the crisis.
- **Contact Tracing:** The government is conducting "contact tracing" to isolate potentially infected individuals.
- **Screening And Testing:** Route maps are being published, urging people to contact the health department for screening and testing.
- **Contact Isolation:** Local government officials and ASHA health workers are assisting in finding infected individuals and ensuring their contacts are isolated.
- **Social mobilization:** It has been implemented, providing communities with essential epidemiological information.
- **Adequate supply of essential commodities:** Particularly food and medicines, has been ensured, especially for vulnerable sections of society.

### Chandrapur's Colour-coded Passes System

- While Maharashtra is responsible for more deaths in the country than other states in comparison. **Chandrapur district in the east of Maharashtra has recorded low instances of death.**
- To maintain it that way, the district administration has implemented a one-of-a-kind pass system that aims to **establish social distance by allocating days on which one member of a family can leave.**
- For instance, the 22,000 families in Ballarpur municipal corporation — the second largest city in the district — **have been divided into five groups. Each group has been assigned a colour-coded pass**
  - Pink, Blue, White, Yellow and Green
  - which specifies the dates on which the pass-holder can go out to buy groceries and other essential items.
- The passes in **Chandrapur**, which has around 85,000 families, are not **colour-coded (they are all white), but the concept is the same**- the population has been separated into six categories, and the passes define the dates for each group.
- The district's 15 blocks, which have a combined population of 26 lakh people, had asked to implement this system and to hire **ASHA (Accredited Social Health Activist) personnel to enforce it.**

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## ROLE OF DISASTER MANAGEMENT ACT 2005

- **Enabling Rapid Response:** The Act's focus on quick action and flexible decision-making facilitated the swift activation of the National Disaster Management Authority (NDMA) and State Disaster Management Authorities (SDMAs), enabling coordinated responses at national and state levels.



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- **Legal Framework for Containment Measures:** The Act provided legal backing for implementing lockdown restrictions, establishing quarantine zones, and enforcing physical distancing measures, crucial for controlling the virus spread.
- **Resource Mobilization and Allocation:** The Act empowered the government to access and utilize funds from the State Disaster Response Fund (SDRF) and National Disaster Response Fund (NDRF) for emergency procurement of medical supplies, PPE kits, and setting up temporary hospital infrastructure.
- **Disaster Management Expertise and Infrastructure:** The existing network of disaster management personnel were mobilized for tasks like contact tracing, community awareness campaigns, and logistics management, leveraging their expertise and resources.
- **Risk Assessment and Planning:** The Act's emphasis on risk assessment and disaster preparedness proved valuable in planning future phases of the pandemic response, including vaccination drives and managing potential future waves.

## Challenges and Limitations

- **Unconventional Disaster:** COVID-19's unique nature as an invisible, long-term threat tested the traditional scope of the DMA designed for sudden, natural disasters. Adapting existing frameworks to this novel situation posed challenges.
- **Focus on Emergency Response:** The Act's emphasis on immediate response measures left long-term recovery and rehabilitation of affected communities less addressed, requiring additional policy interventions.
- **Implementation Discrepancies:** Variations in enforcement and resource allocation across different states highlighted the need for stronger inter-state cooperation and equitable distribution of resources.

### Effectiveness of Various Lockdown Measures, Containment Strategies and Vaccination Drives

- **Vaccination Impact**: A research focuses on vaccination-related policies and provides a detailed analysis of COVID-19 metrics. Vaccination efforts, including boosters, greatly reduce the number of cases, hospitalisations, and fatalities.
- **Lockdowns and Containment procedures**: According to government assessments, lockdown and restriction procedures effectively limit the virus's transmission. By spring 2020, lockdowns had affected more than half of the world's population, proving their widespread usage as a containment method.

## NDMA's Role in Controlling COVID-19 in India

The National Disaster Management Authority (NDMA) played a crucial role in coordinating and strategizing India's response to the COVID-19 pandemic. Its contributions can be broadly divided into policy and guidelines and coordination and implementation:

### Policy and Guidelines

- **Developing comprehensive guidelines:** NDMA issued **National Guidelines for Management of the COVID Pandemic** covering various aspects of the pandemic, including risk assessment, surveillance, quarantine, and isolation protocols. These guidelines were regularly updated based on evolving situations and best practices.
- **Training and resource development:** NDMA created training modules for healthcare workers, volunteers, and administrators on pandemic preparedness and response. Additionally, it facilitated the development of educational materials for public awareness campaigns.
- **Procurement and distribution of resources:** NDMA played a key role in procuring and distributing essential medical equipment like PPE kits, ventilators, and oxygen concentrators, ensuring efficient resource allocation across states.
- **International collaboration**: NDMA actively collaborated with international organizations like WHO and UN agencies to share best practices, access technical expertise, and secure additional resources for India's fight against the pandemic.

### Coordination and Implementation

- **Providing technical and financial support:** NDMA offered technical and financial assistance to State Disaster Management Authorities (SDMAs) for implementing COVID-19 response measures. This included supporting the establishment of isolation facilities, testing centres, and healthcare infrastructure upgrades.
- **Task force formation:** NDMA established dedicated task forces focusing on specific areas like logistics, medical response, and communication. These task forces facilitated coordinated action and decision-making across different departments and agencies.
- **National-level monitoring and guidance:** NDMA closely monitored the pandemic situation across the country through data analysis and regular consultations with experts. Based on these insights, it provided real-time guidance and recommendations to SDMAs and other stakeholders.
- **Guidelines for Vaccination:** NDMA collaborated with the Ministry of Health to develop the national vaccination program, including priority groups, vaccine allocation strategies, and vaccine hesitancy management.

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## Role of State Disaster Management Authorities (SDMAs)

### Implementation on Ground Level

- **Enforcement of containment measures:** SDMAs were responsible for implementing lockdown and containment measures within their jurisdictions, including movement restrictions, curfews, and quarantine protocols.
- **Coordination with local authorities:** SDMAs worked closely with district administrations, municipalities, and other local bodies to ensure effective implementation of COVID-19 response initiatives on the ground.
- **Healthcare infrastructure management:** SDMAs managed COVID-19 infrastructure within their states, overseeing the establishment and operation of isolation facilities, testing centres, and healthcare facilities dedicated to the pandemic response.
- **State-specific action plans:** SDMAs adapted the NDMA's national guidelines to develop state-specific action plans tailored to their local contexts and risk levels.

# BEST PRACTICES IN INDIA

## Odisha: Women Leading from the Front to Contain the Pandemic

- **Mission Shakti:** In Odisha, 7 million women of Mission Shakti have taken the lead in the fight against COVID-19. They have helped contain the spread of the virus and provided various community services.
- **Mo Jeevan pledge:** SHGs helped implement the 'Mo Jeevan' pledge to all habitations across the state, educating 15.3 million persons to break the chain of contact. Many of them have also helped spread awareness about social distancing and safety in rural areas.
- **Mask-making a philanthropic activity:** 1339 Mission Shakti SHGs with experience in stitching garments and producing jute items have committed to undertake mask-making as a philanthropic activity.
- **Mask and Livelihoods:** 6.5 million reusable face masks were produced and sold at nominal prices to frontline workers. Another 0.3 million masks were distributed free of cost by SHGs among the poor and the vulnerable to contain the pandemic. This promoted the livelihoods of rural women.

## Mumbai's Dharavi Model

The 'Dharavi model' of COVID-19 management and the vaccination drive have helped contain the second wave in the area, according to officials.

- **Quarantine centres** were set up in schools, colleges, parks, hostels, and community halls to house those segregated post-screening.
- **Visiting doctors** instilled confidence in people, leading to self-identification of symptoms.
- Three **private hospitals** were acquired for treatment, and the Sion public hospital was designated for COVID-19.
- **Clinics** indicated where screening drives should be carried out, with 50-60% positive cases identified through screening and testing.
- **Integrated Medical Practitioners (IMP)** played a significant role, sharing potential COVID patients with experienced allopathic doctors for advice.
- **Community members** played a stellar role in creating containment zones, barricading areas, and promoting precautionary messages.
- **Police** used drones to check gatherings distribute food, and spread awareness.

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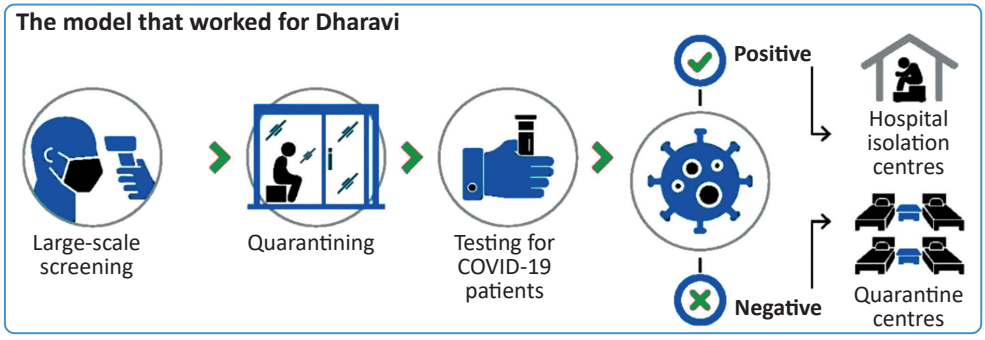


Fig. 10.1: Dharavi Model of COVID-19 Management

## Rajasthan's Bhilwara, 'Ruthless Containment Model

- Bhilwara, Rajasthan, has implemented a "**ruthless containment**" model to break the chain of novel Coronavirus transmission.
- The containment model involved **isolation of the district**, screening in the city and rural areas, and sending people showing symptoms to home quarantine.
- The district administration also acquired **hotels, resorts, hostels, and Dharamshala** to arrange 1,500 quarantine beds and 14,400 normal beds.
- During the ongoing "**all-down curfew**", essential items were being delivered to city residents.



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## BEST PRACTICES IN THE WORLD

| Strategy | Country | Best Practices |
|---|---|---|
| First Elimination then Mitigation Strategy | New Zealand | It got the country through the first 18 months of the pandemic until vaccines became widely available, giving it very low Covid-19 mortality rates. Life expectancy actually increased during this period. Protecting public health has also been good for protecting the economy, resulting in relatively good economic growth and low unemployment. |
| Robust Surveillance and Contact Tracing | South Korea | Tracked contacts using mobile phone data and deployed rapid test kits. |
| Transparent and Consistent Communication | Singapore | Held regular press conferences and launched public awareness campaigns, leading to high public trust in government measures. |
| Strengthening Healthcare Infrastructure | Taiwan | Stockpiled medical supplies and trained healthcare workers, enabling a rapid response to outbreaks and maintaining low case fatality rates. |
| Targeted Social Support Programs | Costa Rica | Launched a broad cash transfer program(Star Program) for vulnerable households, mitigating the economic impact of lockdowns and reducing poverty rates. |
| Prioritization of Vulnerable Groups | Ireland | Provided healthcare workers with priority access to personal protective equipment (PPE) and implemented dedicated testing protocols for frontline staff. |
| Emphasis on Mask-Wearing and Hygiene Practices | Japan | Achieved near-universal mask-wearing compliance (>90%) through public awareness campaigns and social norms. |
| Data-Driven Decision-Making | Israel | Launched a national contact tracing app with high user adoption, informing targeted isolation measures and reducing transmission effectively. |

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## SO HOW WE CAN MANAGE SUCH DISASTERS IN THE FUTURE?

### Strategic and Tactical Response

- **Prioritize evidence-based decision-making:** Align public health measures with expert recommendations and adapt strategies as the situation evolves.
- **Balance urgent response measures with long-term economic and social considerations:** Minimize disruption and foster sustainable recovery.
- **Tailor responses to specific regions and communities based on their needs and vulnerabilities:** Avoid a one-size-fits-all approach.

### Communication and Collaboration

- **Clear and consistent communication:** Ensure transparent and timely communication of risks, safety protocols, and government initiatives to build public trust and compliance. This will control **vaccine hesitancy and the fake news menace.**
- **Enhanced inter-agency coordination:** Improve collaboration between different government departments, healthcare agencies, and research institutions for rapid and effective response.

Sonu Sood, once primarily known as a Bollywood actor, became a beacon of hope and compassion during the COVID-19 pandemic. His humanitarian efforts ranged from opening his hotel to healthcare workers to providing food for thousands through the Shakti Annadanam initiative. He facilitated the return of stranded migrant workers to their homes, arranged employment opportunities, and even supported students with scholarships and free mobile phones for online education. Mr. Sood also organized flights to bring back Indian students stranded abroad and tirelessly worked to provide hospital beds, medicines, and oxygen to those in need.

- **Community engagement:** Involve local communities in planning, implementing, and monitoring disaster response measures, leveraging their knowledge and resilience.
  - For example, In Brazil people formed **"solidarity networks"** to distribute food, hygiene products, and information to residents, often using improvised communication channels like WhatsApp groups.



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## Strengthening Infrastructure and Systems

- **Invest in healthcare infrastructure.** Strengthen public health systems, including hospitals, medical supplies, and personnel training, to be better prepared for future medical emergencies.
- **Develop robust early warning systems.** Implement effective early warning systems and risk assessment tools to predict and prepare for potential disasters, including climate-related events.
- **Utilize technology for data collection, analysis, and communication.** Use technology to efficiently monitor the situation, allocate resources, and coordinate response efforts. In this sector, the government has done significantly well with innovations such as **Arogya Setu and CO-WIN.**

## Addressing Social and Economic Challenges

- **Focus on vulnerable populations:** Pay special attention to the needs of marginalized communities, women, children, and those with disabilities. Ensure equitable access to resources and support during and after disasters.
- **Economic resilience and livelihood protection:** Implement financial support programs and social safety nets to mitigate the economic impact of disasters on vulnerable groups and businesses. **The PM Garib Kalyan Yojana** was a good step in this direction.
- **Building community resilience:** Invest in long-term programs that enhance community preparedness, empower individuals, and promote sustainable livelihoods for better recovery from future disasters.

## Learning from Experience

- **Conduct thorough evaluations.** Analyze the strengths and weaknesses of the COVID-19 response to identify areas for improvement and inform future disaster management strategies.
- **Share knowledge and best practices.** Disseminate lessons learned and successful interventions within India and internationally to contribute to global disaster preparedness and response.
- **Unpredictability as the New Normal**: Disaster prediction is difficult, even with advances in information technology. Natural disasters are becoming more unpredictable due to climate change. Disaster management techniques must evolve to meet the changing world of unpredictability.

### IGNITE YOUR MIND

During the COVID-19, People faced acute scarcity of Basic needs such as hospital beds, medicines and even graveyards. Can we develop flexible healthcare systems that can rapidly expand and adapt to accommodate sudden increases in patient needs during future pandemics?

- **Continuously adapt and evolve.** Embrace a flexible and adaptable approach to disaster management, constantly updating systems and strategies based on new challenges and emerging threats.
- **Humanity at its Core- Empathy and Compassion:** The humanitarian approach is key to disaster management. Victims deserve empathy and assistance. Addressing socioeconomic inequities and inclusion is important.
  - Incidents such as spraying disinfectants on migrants could be avoided in future.

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## CONCLUSION

COVID-19 has been termed the highlight these words in orange Event, as it was unprecedented, came as a surprise and changed the lives of people in numerous aspects. As a disaster, it was new for the administrators to deal with a crisis at such scale and longevity. Thus, it should be remembered that the nature of disaster is unpredictable and humans should be ready for all kinds of events. At the same time, mitigation and care for nature are of utmost importance to restrict hazards from becoming disasters.



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